

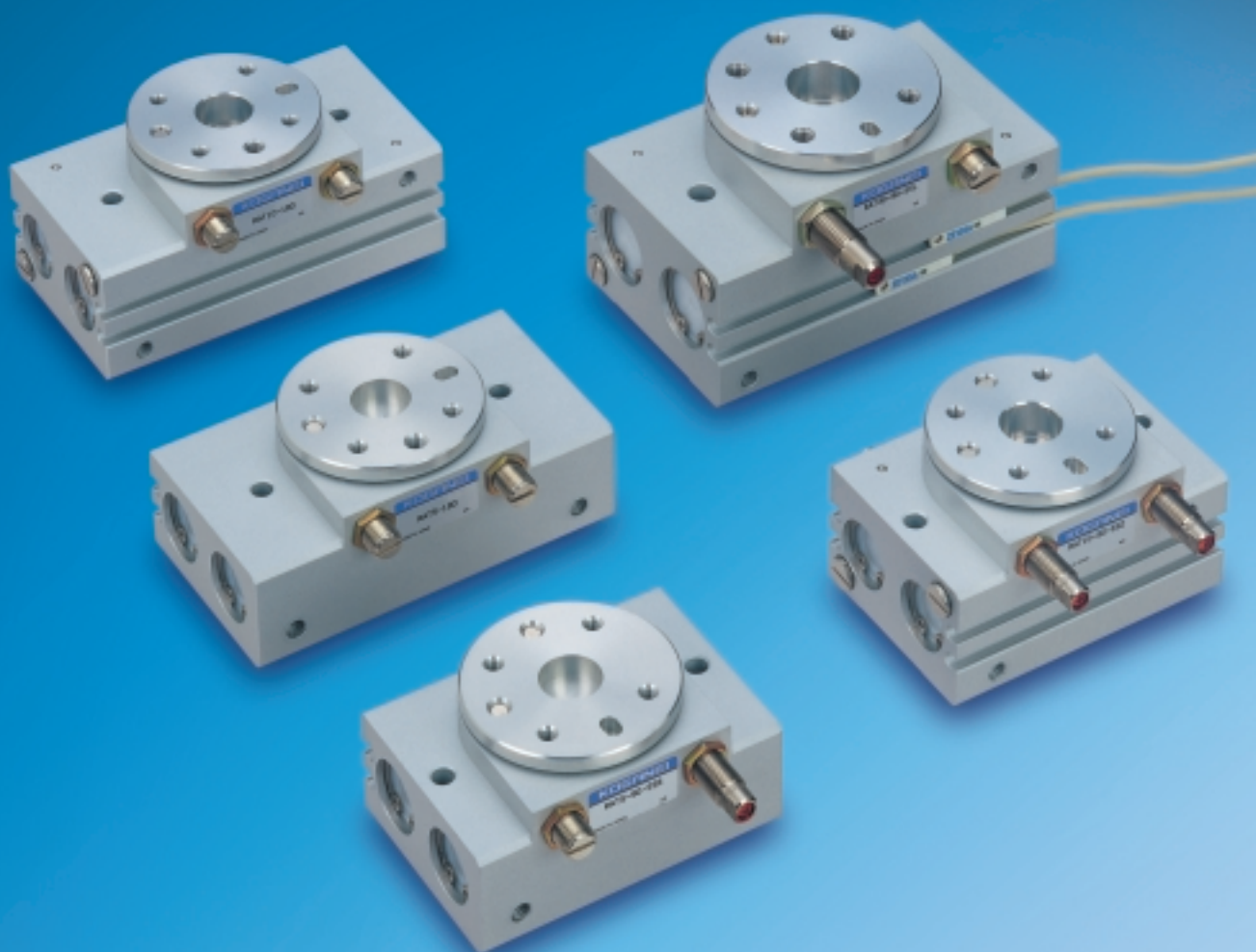
<http://www.koganei.co.jp>

ISO9001 ISO14001



NEW
Products

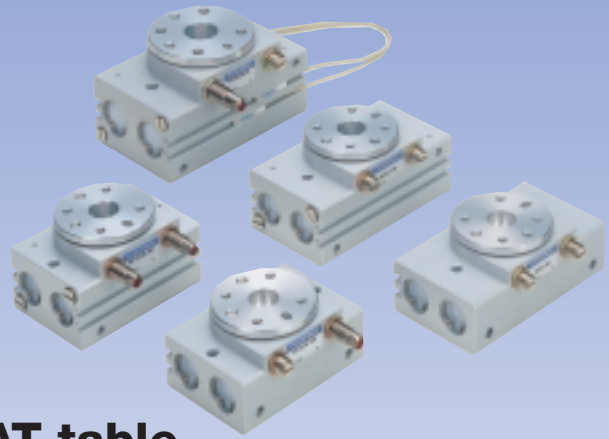
ROTARY ACTUATORS RAT Series



**Light Weight and High Precision
Rotating Table Type**

ROTARY ACTUATORS

RAT Series



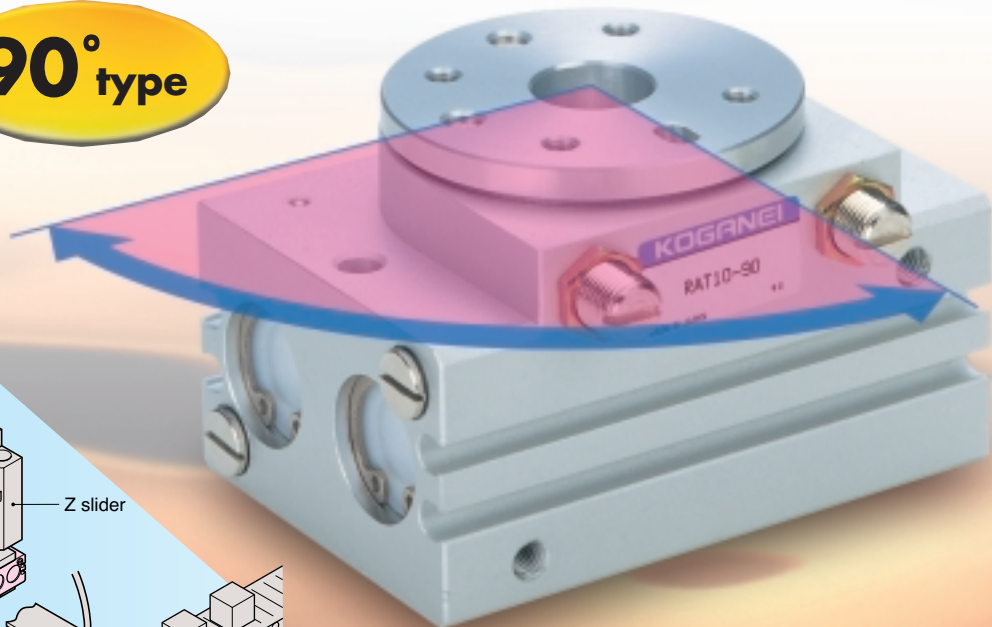
Light Weight and Compact

- High precision by using bearing.
- Work is easily mounted on the RAT table.

Two types are available for swing angle, **90°** type and **180°** type.

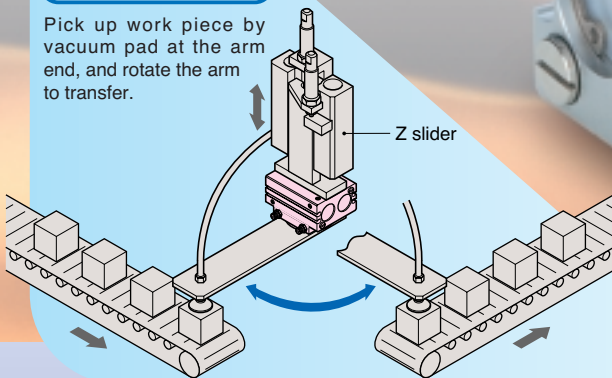
By adjusting thread length of rubber stopper or shock absorber, $\pm 5^\circ$ adjustment at the end of swing stroke is possible.

90° type



Application example

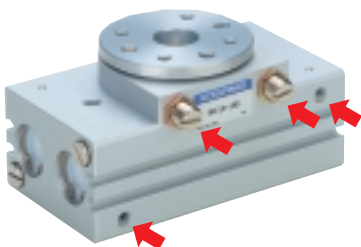
Pick up work piece by vacuum pad at the arm end, and rotate the arm to transfer.



Piping and adjusting swing angle are possible on one surface.

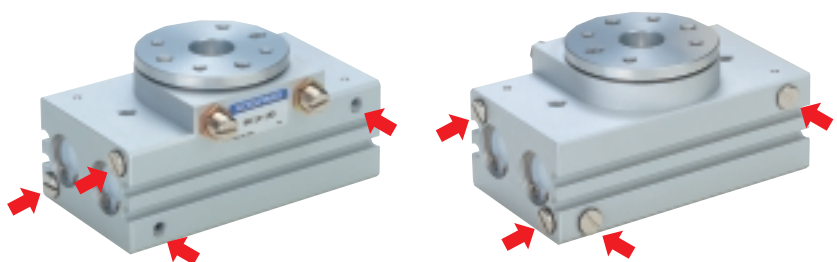
Piping and adjusting swing angle is possible on one surface throughout the product range.

By using a vertical lead wire sensor, even lead wire can be run out in the same surface. (Except RAT5)



Piping connection is possible on four surfaces. (One surface for RAT 5)

Piping direction can be selected for four surfaces. This enables easy piping in confined spaces or in work installed condition. For the piping location and swing direction, see p.23.

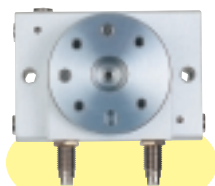




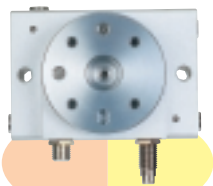
Caution Always read the "Safety Precautions" on page 3 before use.

Four types of cushioning are possible.

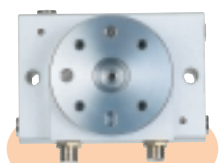
The same mounting thread is used for both the rubber stopper and shock absorber. This allows for change of the rubber stopper to a shock absorber if required later on, or vice versa.



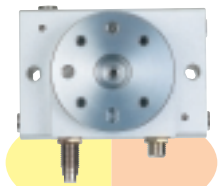
[With shock absorber on both sides]



[With shock absorber on right side]
(Mounted at clockwise rotation end)



[With rubber stopper on both sides]



[With shock absorber on left side]
(Mounted at counterclockwise rotation end)

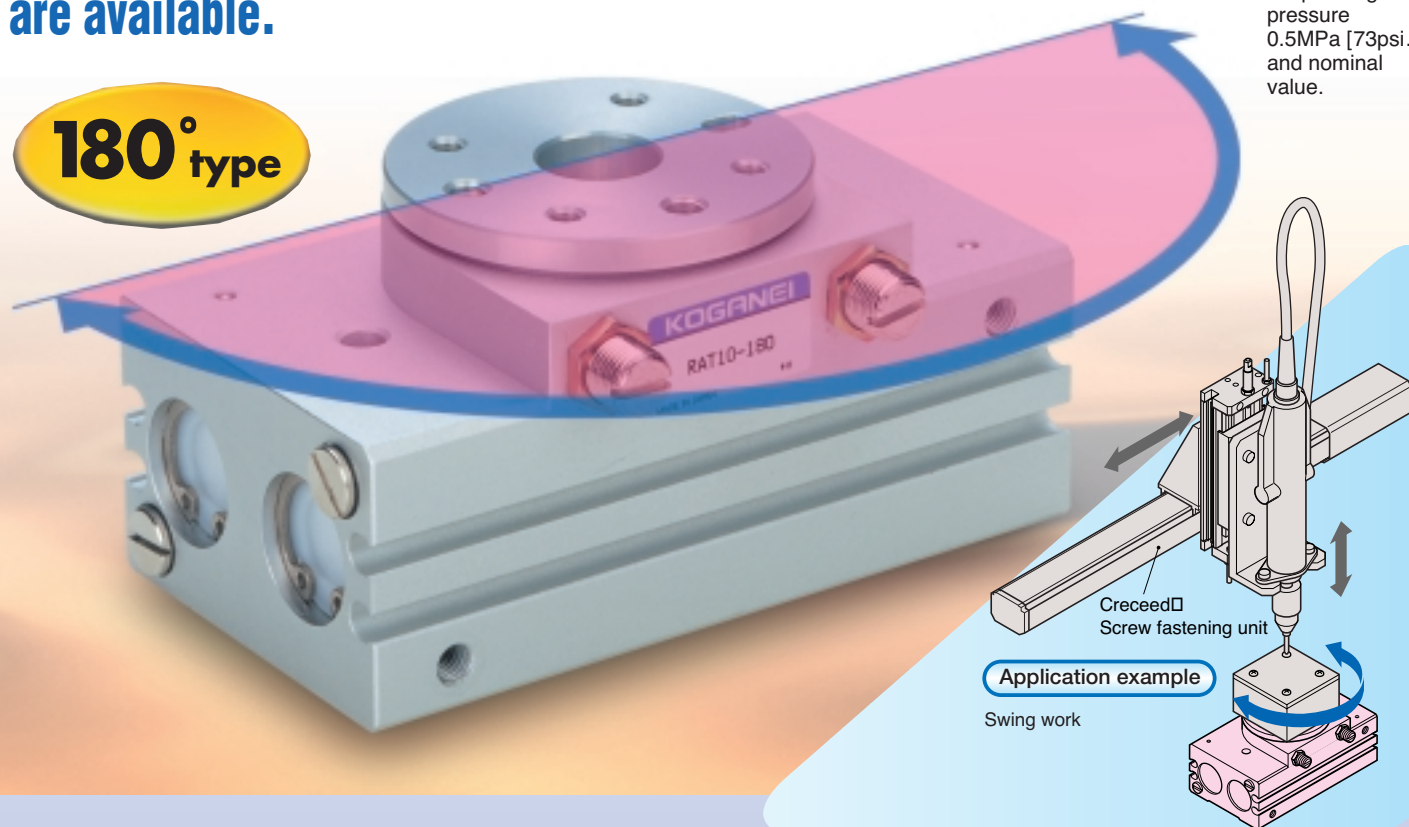
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3 types of torque, **0.5, 1.0, 3.0** ^{Note} **N·m** [**0.4, 0.7, 2.2** **lbf·ft**] are available.

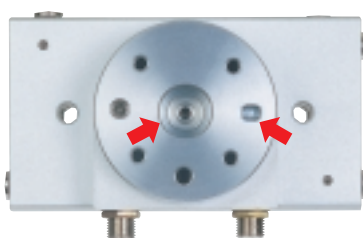
Note: At operating pressure 0.5MPa [73psi.], and nominal value.

180° type



Locating hole on table and bottom of the body are available.

Locating hole and mounting hole are common between 90° and 180° types. Dimensions of those are different in longitudinally only; consequently replacement between 90° type and 180° type is easy. For details in dimensions, refer to pages 24 to 27.



Embedded type sensor switch is available.

Sensor switch mounting groove is available on two surfaces. For RAT5, it is available on one surface.



Before selecting and using products, please read all the Safety Precautions carefully to ensure proper product use.

The Safety Precautions shown below are to help you use the product safely and correctly, and to prevent injury or damage to assets beforehand.

Follow the Safety Precautions for: ISO4414 (Pneumatic fluid power—Recommendations for the application of equipment to transmission and control systems), JIS B 8370 (Pneumatic system regulations)

The directions are ranked according to degree of potential danger or damage: “DANGER!” “WARNING!” “CAUTION!” and “ATTENTION!”

 DANGER	Expresses situations that can be clearly predicted as dangerous. If the noted danger is not avoided, it could result in death or serious injury. It could also result in damage or destruction of assets.
 WARNING	Expresses situations that, while not immediately dangerous, could become dangerous. If the noted danger is not avoided, it could result in death or serious injury. It could also result in damage or destruction of assets.
 CAUTION	Expresses situations that, while not immediately dangerous, could become dangerous. If the noted danger is not avoided, it could result in light or semi-serious injury. It could also result in damage or destruction of assets.
 ATTENTION	While there is little chance of injury, this content refers to points that should be observed for appropriate use of the product.

■ This product was designed and manufactured as parts for use in General Industrial Machinery.

- Before selecting the equipment and using any product, always read the Safety Precautions, the Catalog, the Instruction Manual, etc.
- After reading the Instruction Manual, etc., always place the Manual where it can be easily available for reference to users of this product.
- If transferring or lending the product to another person, always attach the Instruction Manual, etc., to the product where it is easily visible, to ensure that the new user can use the product safely and properly.
- The danger, warning, and caution items listed under these “Safety Precautions” do not cover all possible cases. Read the catalog and user’s manual carefully, and always keep safety first.

DANGER

- Do not use for the purposes listed below:
 1. Medical equipment related to maintenance or management of human lives or bodies.
 2. Mechanical devices or equipment designed for the purpose of moving or transporting people.
 3. Critical safety components in mechanical devices.
 This product has not been planned or designed for purposes that require advanced stages of safety. It could cause injury to human life.
- Do not use in locations with or near dangerous substances such as flammable or ignitable substances. This product is not explosion-proof. It could ignite or burst into flames.
- When attaching the product, always ensure that it is securely fixed in place. Dropping or falling the product or improper operation could result in injury.
- Persons who use a pacemaker, etc., should keep a distance of at least one meter away from the product. There is the possibility that the pacemaker will malfunction due to the strong magnet built into the product.
- Never attempt to remodel the product. It could result in abnormal operation leading to injury, electric shock, fire, etc.
- Never attempt inappropriate disassembly or assembly of the product’s basic configurations, or of its performance or functions. It could result in injury, electric shock, fire, etc.
- Do not splash water on the product. Spraying it with water, washing it, or using it underwater could result in malfunction of the product leading to injury, electric shock, fire, etc.
- While the product is in operation, avoid touching it with your hands or otherwise approaching too close. In addition, do not make any adjustments to the interior or to the attached mechanisms (removal, etc., of swing adjustment mechanism, sensor switch mounting position, piping tubes, or sealing plugs) while in operation. The actuator can move suddenly, possibly resulting in injury.
- When operating the product, always install a speed controller, and gradually loosen the needle valve from a choked state to adjust the speed increasing. Failure to make this adjustment could result in sudden movements, putting lives at risk.

WARNING

- Do not use this product in excess of its specification range. Such use could result in product breakdowns, function stop or damage.
- Before supplying air or electricity to the device and before starting operation, always conduct a safety check of the area of machine operation. Unintentional supply of air or electricity could possibly result in electric shocks, or in injury caused by contact with moving parts.
- Do not touch the terminal and the miscellaneous switches, etc., while the device is plugged in. There is the possibility of electric shock and abnormal operation.
- Do not allow the product to be thrown into fire. The product could explode and release toxic gases.
- Do not sit on the product, place your foot on it, or place other objects on it. Accidents such as falling and tripping over could result in injury. Dropping the product may damage or break the product resulting in abnormal, improper or erratic operation.
- When conducting any kind of operation for the product, such as inspection, repair, installation/removal of piping, or replacement, always turn off the air supply completely and confirm that residual pressure inside the product or in piping connected to the product is zero before proceeding. In particular, be aware that residual air will still be in the air compressor or air storage tank. The actuator could abruptly move if residual air pressure remains inside the piping, causing injury.
- Do not use the actuator for equipment whose purpose is absorbing the shocks and vibrations of mechanical devices. It could break and possibly result in injury or in damage to mechanical devices.
- Avoid scratching the cords for the sensor switch lead wires, etc. Letting the cords be subject to scratching, excessive bending, pulling, rolling up, or being placed under heavy objects or squeezed between two objects, may result in current leaks or defective continuity that lead to fires, electric shocks, or abnormal operation.

- Do not subject the sensor switch to an external magnetic field during actuator operation. Unintended movements could result in damage to the equipment or in personal injury.
- Use within the recommended load and specified frequency. Use exceeding the recommended load and specified frequency could damage the table, etc., and raise the possibility of damage to equipment or of personal injury. Such operation will also drastically reduce the unit's operating life.
- Use safety circuits or system designs to prevent damage to machinery or injury to personnel when the machine shuts down due to emergency stop or electrical power failure.
- Install relief valves, etc., to ensure that the actuator does not exceed its rated pressure when such pressure is rising due to external forces on the actuator. Excessive pressure could lead to breakdown and damage.
- In initial operations after the equipment has been idle for 48 hours or more, or has been in storage, there is a possibility that contacting parts will stick, resulting in equipment operation delays or sudden movements. For these initial operations, always run a test operation before use to check that operating performance is normal.



CAUTION

- Do not use in locations under direct sunlight (ultraviolet), in locations subject to dust, salt, or iron powder, in locations with humidity, or in the media and/or the ambient atmospheres that include organic solvents, phosphoric ester-based hydraulic fluids, sulfur dioxide gas, chlorine gas and acids. These conditions could lead to functional shutdowns, sudden degraded performance, or shortened operating life in a brief period of time. For the materials used, see Major Parts and Materials.
- When mounting the product, leave room for adequate working space around it. Failure to assure adequate working space will make it more difficult to conduct daily inspections or maintenance, which could eventually lead to system shutdown or damage to the product.
- Do not bring floppy disks or magnetic media, etc., within one meter of the product. There is the possibility that the data on the floppy disks will be destroyed due to the magnetism of the magnet.
- Do not use the sensor switch in locations subject to large electrical currents or strong magnetic fields. It could result in erratic operation. In addition, do not use magnetized materials in the mounting bracket. The magnetism could leak, possibly resulting in erratic operation.
- Never use another company's sensor switch with these products. It could possibly cause error or accidental operation.
- Do not scratch, dent, or deform the actuator by climbing on the product, using it as scaffold, or placing objects on top of it. It could result in damaged or broken products that result in operation shutdown or degraded performance.
- When performing mounting or adjustment work, put up "now working" signs to prevent unintentional supplying air or electrical power, etc. Such accidental supplies may cause electrical shock, or sudden activation of the actuator that could result in physical injury.
- Do not pull on the cords of the lead wires, etc., of the sensor switches mounted on the actuators, grab them to lift, or place heavy objects or excessive loads on them. Such action could result in current leaks or defective continuity that lead to fires, electric shocks, or abnormal operation.



ATTENTION

- When considering the possibility of using this product in situations or environments not specifically noted in the Catalog or user's Manual, or in applications where safety is an important requirement, such as in an airplane facility, combustion equipment, leisure equipment, safety equipment and other places where human life or assets may be greatly affected, take adequate safety precautions such as application with enough margins or fail-safe measures for ratings and performance. Please consult KOGANEI with any questions.
- Always check the catalog and other reference materials for product wiring and piping.
- Use a protective cover, etc., to ensure that human bodies do not come into direct contact with the operating section of mechanical devices, etc.
- Do not control in a way that would cause work to fall during power failure. Set the controls so that they prevent the table or work, etc., from falling during power failure or emergency stop of the mechanical devices.
- When handling the product, wear protective gloves, safety glasses, safety boots, etc., to assure safety.
- When the product can no longer be used, or is no longer necessary, dispose of it appropriately as industrial waste.
- Pneumatic equipment can exhibit degraded performance and function over its operating life. Always conduct daily inspections of the pneumatic equipment, and confirm that all requisite system functions are satisfied, to prevent accidents from happening.
- For inquiries about the product, contact your nearest Koganei sales office or Koganei overseas division. The address and telephone number is shown on the back cover of this catalog.



OTHER

- Always observe the following items.
 1. When using this product in pneumatic systems, always use genuine KOGANEI parts or compatible parts (recommended parts).
When conducting maintenance and repairs, always use genuine KOGANEI parts or compatible parts (recommended parts). Always observe the required methods.
 2. Do not attempt inappropriate disassembly or assembly of the product relating to basic configurations, or its performance or functions.

Koganei cannot take responsibility for behavior in intentional disregard of these safety precautions.



Design and Selection

Warning

1. Check the specifications.

As use of this equipment over the specified ranges of voltage, current, temperature, shock, etc., could result in breakdown or abnormal operation, always read the specifications carefully to ensure correct use.

2. Avoid mounting actuators in close proximity.

Mounting two or more actuators with sensor switches in close proximity could result in erroneous operation of the sensor switch, due to magnetic field interference with the system.

3. Caution about sensor switch ON time for positioning detection at intermediate stroke position.

Take caution that if the sensor switch is mounted at an intermediate position of the actuator stroke for detection of the piston travel, the sensor switch actuation time may be too short when the actuator speed is very rapid, so that the load (sequencer, etc.) may fail to activate.

Maximum cylinder speed for positioning detection

$$V(\text{mm/s}) [\text{in./s}] = \frac{\text{Sensor switch actuation range } [\text{mm}] [\text{in.}]}{\text{Time required for activating load } [\text{ms}]} \times 1000$$

4. Keep wiring as short as possible

In reed sensor switches, in particular, excessively long wiring (10m or more) can shorten the operating life of the sensor switch with capacitive surges. If the wiring must be long, install the protection circuits listed in the catalog for inductive or capacitive loads, as well.

5. Avoid repeated or excessive bending or pulling of lead wires.

Applying repeated bending stress or tension force on the lead wire could result in wire breakage.

6. Check for leak current.

Two-lead wire solid state sensor switches produce leak current to activate their internal circuits, and the current flows even when turned off condition. Check to ensure they satisfy the following formula.

Input off current of programmable controller > Leak current

If the above formula cannot be satisfied, select a three-lead wire solid state sensor switch, instead. Also note that parallel connection of a total of n sensor switches will lead to n times the leak current.

Caution

1. Check for sensor switch internal voltage drop.

Series connection of reed sensor switches with indicator lamps or two-lead wire solid state sensor switches causes increasing internal voltage drop, and the load may fail to activate. A total of n sensor switches will lead to n times the internal voltage drop. Ensure that the system satisfies the following formula.

Supply voltage – Internal voltage drop $\times n$ > Minimum operating voltage for load

In relays with rated voltage of less than 24VDC, check to see whether the above formula is satisfied, even in the case of $n = 1$. If the above formula cannot be satisfied, select either a reed sensor switch without indicator lamp, or a three-lead wire solid state sensor switch.

2. Do not use with other companies' actuators.

The sensor switches are designed for use with Koganei actuators. Use with other companies' actuators could lead to abnormal operation.



Installation and Adjustment

Warning

1. Do not subject the sensor switch to an external magnetic field during actuator operation.

Unintended movements could result in damage to the equipment or in personal injury.

Caution

1. Ensure a safe mounting environment for the actuators with sensor switches.

Do not use sensor switches in places where large current or magnetic fields are present. This could lead to unintentional operation. Do not use magnetic material for the mounting brackets. It could result in erratic operation.

2. Install sensor switches in the center of its operating range.

Adjust the mounting position of a sensor switch so that the piston stops in the center of its operating range (the range while the sensor turns on). Operations can be unstable if mounted at the end of the operating range (at the boundary near ON and OFF). Also be aware that the operating range can vary with changes in temperature.

3. Follow the tightening torque of sensor switches when mounting.

Over-tightening beyond the allowed fastening torque may damage the mounting screws, mounting brackets, sensor switches, etc. In addition, insufficient tightening torque could cause the sensor switch position to change, resulting in operating instability.

For the tightening torque, see p.31.

4. Do not attempt to transport the actuator while the sensor switch lead wires are attached.

After mounting a sensor switch to an actuator, do not grab the lead wires to lift the actuator. Never do this, as it could result in lead wire disconnections, and could also apply stress to the interior of the sensor switch, resulting in breakage of internal elements.

5. Do not drop switches, or bump them against others.

During handling of switches, do not apply excessive shocks (294.2m/s² {30G} [965ft/s²] or more) such as hitting, dropping, or bumping. In reed sensor switches, the contact reed can be activated unintentionally, causing it to send or break sudden signals. It can also cause changes in the contact interval that lead to changes in sensor switch sensitivity and result in erratic operation. Even if the sensor switch case is undamaged, the inner parts of the sensor switch may suffer breakdown or erratic operation.



Wiring

Danger

1. Avoid letting moving objects near a sensor switch come into contact with them.

When actuators with sensor switches move, or when moving objects are nearby, do not let the moving objects come into contact. In particular, lead wires could become worn out or damaged, inducing operating instability in the sensor switch. In the worst case, it could result in current leaks or electrical shocks.

2. Always turn off the power supply for wiring work.

Conducting wiring work while the power is on could result in electric shocks. Also, incorrect wiring could damage sensor switches in an instant. Turn on the power only after wiring work is complete.

Warning

1. Check the Catalog, etc., to ensure that the sensor switch wiring is correctly connected.

Miswiring could result in abnormal operation.

2. Do not share the same wiring with power or high voltage lines.

Avoid wiring in parallel to or shared with power or high voltage lines. The sensor switch or control circuit may suffer electric noise that results in erratic operation.

3. Avoid repeated or excessive bending or pulling of lead wires.

Applying repeated bending stress or tension force on the lead wire could result in wire breakage.

4. Check polarity in the wiring

In sensor switches that specify polarity (+, -, output), be sure that wiring connections are correct. The wrong polarity could result in damage to the sensor switch.

Caution

1. Avoid short circuiting the loads.

Turning a sensor switch on while the load is short-circuited causes overcurrent, which can damage the sensor switch in an instant.

Example of short-circuited load: Sensor switch's output lead wire is directly connected to the power supply.



General Precautions

Media

1. Use air for media. Consult with us for the use of any other media.
2. For the air used in the rotary actuator, use clean air that does not contain deteriorated compressor oil. Install a filter (filtration rate of 40 μ m or less) near the rotary actuator or valve to remove collected liquid or dust. Also, clean out the collected liquid of the air filter on a regular basis.

Piping

1. Always flush out the piping (blow through with compressed air) before connecting the rotary actuator. Entering cutting chips, sealing tape, rust, or other materials generated during plumbing could result in air leaks or other operational malfunctions.
2. Observe the following tightening torques when screwing piping or fittings into the rotary actuator.

Connecting thread	Tightening torque N·cm{kgf·cm} [lbf·ft]
M5×0.8	157{16} [1.16]

Lubrication

This product can be used without lubricating oil. If lubrication must be used, use turbine oil Class 1 (ISO VG32) or its equivalent. Do not use spindle oil or machine oil.

Atmosphere

If using in locations in oily or wet surroundings, protect with a cover, etc.

Start-Up

When starting up operations of a device and the rotary actuator by supplying compressed air rapidly, it could not control the speed due to the structure of the rotary actuator, resulting in damage to the device and rotary actuator. When supplying compressed air to a device and the rotary actuator where the air has been exhausted, always ensure that the table is in a secure position and cannot be moved further, paying attention to safety, and then apply air pressure from the connection port of not making move the table. For the piping location and swing direction, see p.23.

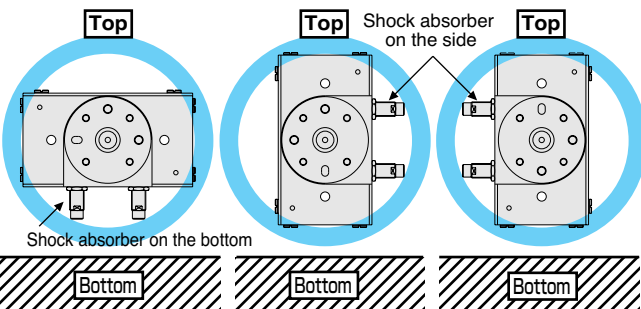
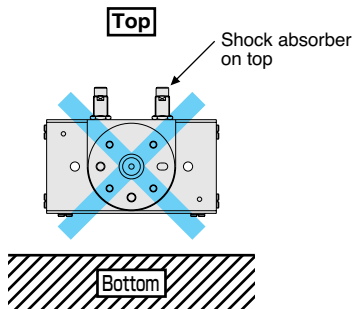
Handling Instructions and Precautions



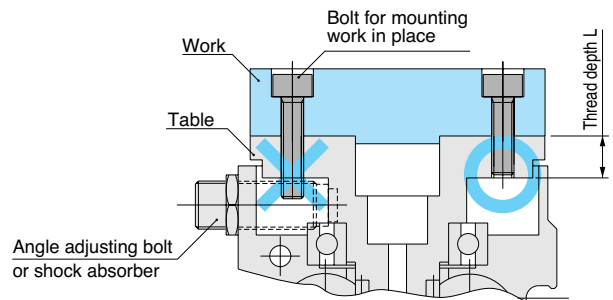
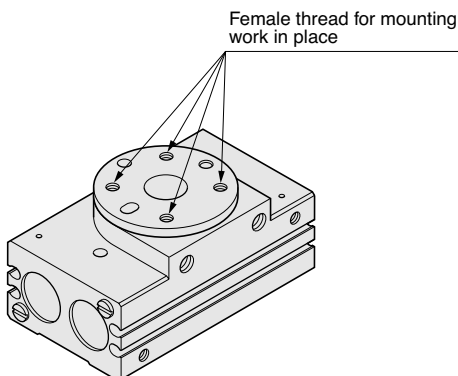
Mounting

Mounting

1. Models with rubber stoppers on both sides can be freely mounted in any direction. If using models with shock absorbers (-SS2, -SSR, -SSL), however, avoid using with the shock absorber mounted on top of the body. This position drastically reduces the shock absorber's operating life. When using with shock absorber, locate the shock absorber so that it is mounted on the bottom or side of the body.



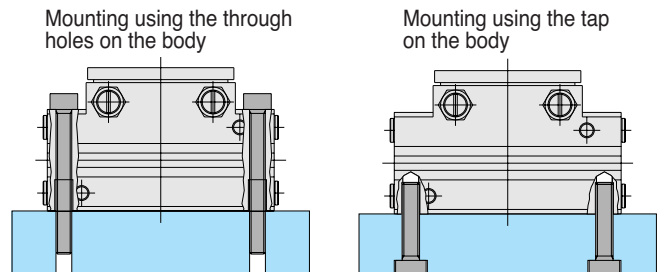
2. Ensure that the mounting surface is flat. Twisting or bending during the mounting could result in air leaks or defective operation.
3. Avoid scratching or denting the mounting surface of the rotary actuator, as it could damage the flatness.
4. Shocks or vibrations might loosen the bolt, consider taking loosening preventive measure, etc.
5. For work mounting, female threads are available for installing the work in place on the table. Always use bolts so that the screw length is less than the depth of the female thread. Use longer bolts than the female thread will interfere with the angle adjusting bolt or shock absorber, and prevent them from working properly. When mounting the work, tighten the bolts within the range of the tightening torque.



Model	Thread size	Thread depth L mm [in.]	Maximum tightening torque N·m [lbf·ft]
RAT5	M4×0.7	7 [0.28]	1.37 [1.01]
RAT10			
RAT30	M6×1.0	8 [0.32]	4.80 [3.54]

Caution: When using a bolt to mount the work in place on the table, hold either the table or work in place during the operation. Holding the body in place for tightening will apply excessive moment to the stopper, rubber stopper and shock absorber, resulting in a change of angle.

6. The rotary actuator RAT series can be mounted in either of the two ways shown below. When mounting, ensure that the tightening torque is within the range of allowable values.

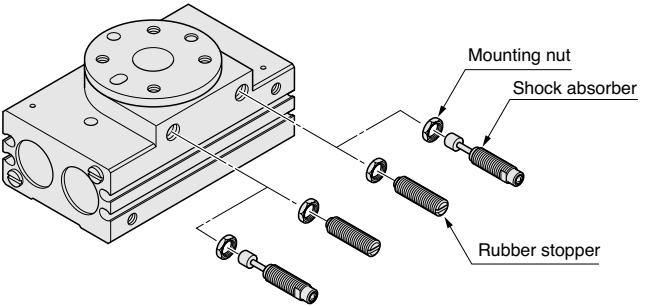


Model	Mounting method	Thread size	Maximum tightening torque N·m [lbf·ft]
RAT5	Through hole	M5×0.8	2.84 [2.09]
	Female thread	M6×1.0	4.80 [3.54]
RAT10	Through hole	M6×1.0	4.80 [3.54]
	Female thread	M8×1.25	12.0 [8.85]

Handling Instructions and Precautions

Rubber stopper and shock absorber replacement instructions

Loosen and remove the mounting nut of the rubber stopper or shock absorber. Screw in the new rubber stopper or shock absorber to the proper position, and then tighten the mounting nut and fix in place. When tightening the nut, ensure that the tightening torque is within the range of setting values.



Swing angle adjustment

1. The rotary actuator RAT series uses rubber stoppers or shock absorbers for angle adjustment, in the ranges shown on p.23. For both clockwise and counterclockwise rotation, rotating the rubber stopper or shock absorber to the right (clockwise) will reduce the swing angle. After completing angle adjustment, tighten the nut and fix in place.
2. Always follow the swing angle within the specified range for use. For the shock absorber, in particular, the angle between the load applying direction and the axial center line of the shock absorber exceeds the allowable angle variation, it could damage the product.
3. The rubber stopper or shock absorber are only temporarily tightened at time of delivery. For actual use, always tighten the nut to fix in place.
4. When tightening the nut, ensure that the tightening torque is within the range shown below.

Model	Nut size	Maximum tightening torque N·m [lbf·ft]
RAT5	M8×0.75	2.45 [1.81]
RAT10		
RAT30	M10×1.0	6.37 [4.70]

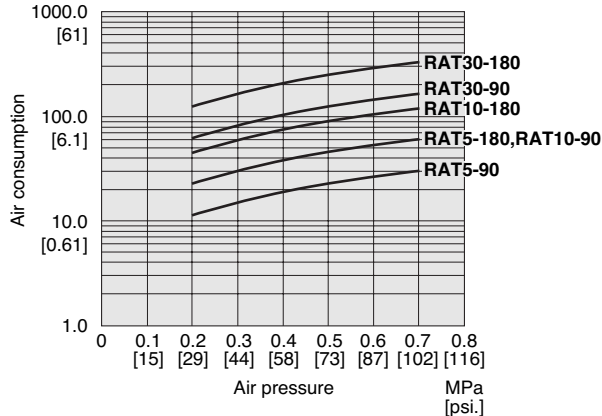
Air Flow Rate and Air Consumption

Air consumption for 1 cycle operation

cm³/cycle (ANR) [in.³/cycle]

Model	Air pressure MPa [psi.]					
	0.2 [29]	0.3 [44]	0.4 [58]	0.5 [73]	0.6 [87]	0.7 [102]
RAT5-90	11.3 [0.69]	15.0 [0.92]	18.7 [1.14]	22.5 [1.37]	26.2 [1.60]	29.9 [1.82]
RAT5-180	22.5 [1.37]	30.0 [1.83]	37.5 [2.29]	44.9 [2.74]	52.4 [3.20]	59.9 [3.66]
RAT10-90	22.5 [1.37]	30.0 [1.83]	37.5 [2.29]	44.9 [2.74]	52.4 [3.20]	59.9 [3.66]
RAT10-180	45.0 [2.75]	60.0 [3.66]	74.9 [4.57]	89.9 [5.49]	104.8 [6.40]	119.8 [7.31]
RAT30-90	61.6 [3.76]	82.0 [5.00]	102.5 [6.25]	122.9 [7.50]	143.3 [8.74]	163.8 [10.00]
RAT30-180	123.2 [7.52]	164.0 [10.01]	204.9 [12.50]	245.8 [15.00]	286.7 [17.50]	327.6 [19.99]

cm³/cycle (ANR)
[in.³/cycle]



Calculation of air flow rate and air consumption

The above graph shows the air consumption for one cycle of the rotary actuator. The actual required air flow rate and air consumption is found by the following formula. Note that the calculation method varies between “RAT5” and “RAT10,30” due to the difference between single piston and double piston construction.

Equation for finding air flow rate (when selecting the F.R.L., valve, etc.)

●RAT5

$$Q_1 = \frac{\pi D^2}{4} \times L \times \frac{60}{t} \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

●RAT10, 30

$$Q_1 = \frac{\pi D^2}{4} \times 2 \times L \times \frac{60}{t} \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

●RAT5

$$Q_1' = \frac{\pi (D')^2}{4} \times \left(\frac{L'}{12}\right) \times \frac{60}{t} \times \frac{P'+14.7}{14.7}$$

●RAT10, 30

$$Q_1' = \frac{\pi (D')^2}{4} \times 2 \times \left(\frac{L'}{12}\right) \times \frac{60}{t} \times \frac{P'+14.7}{14.7}$$

Equation for finding air consumption

●RAT5

$$Q_2 = \frac{\pi D^2}{4} \times L \times 2 \times n \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

●RAT10, 30

$$Q_2 = \frac{\pi D^2}{4} \times 2 \times L \times 2 \times n \times \frac{P+0.1013}{0.1013} \times 10^{-6}$$

Q₁ : Air flow rate required for the cylinder ℓ /min (ANR)
 Q₂ : Cylinder air consumption ℓ /min (ANR)
 D : Inner diameter of the cylinder tube mm
 L : Cylinder stroke mm
 t : Time required by the cylinder for one stroke s
 n : Number of the piston reciprocation cycles/min
 P : Pressure MPa

●RAT5

$$Q_2' = \frac{\pi (D')^2}{4} \times \frac{L'}{12} \times 2 \times n \times \frac{P'+14.7}{14.7}$$

●RAT10, 30

$$Q_2' = \frac{\pi (D')^2}{4} \times 2 \times \frac{L'}{12} \times 2 \times n \times \frac{P'+14.7}{14.7}$$

Q₁' : Air flow rate required for the cylinder ft³/min
 Q₂' : Cylinder air consumption ft³/min
 D' : Inner diameter of the cylinder tube in.
 L' : Cylinder stroke in.
 t : Time required by the cylinder for one stroke s
 n : Number of the piston reciprocation cycles/min
 P' : Pressure psi.

Cylinder bore and stroke

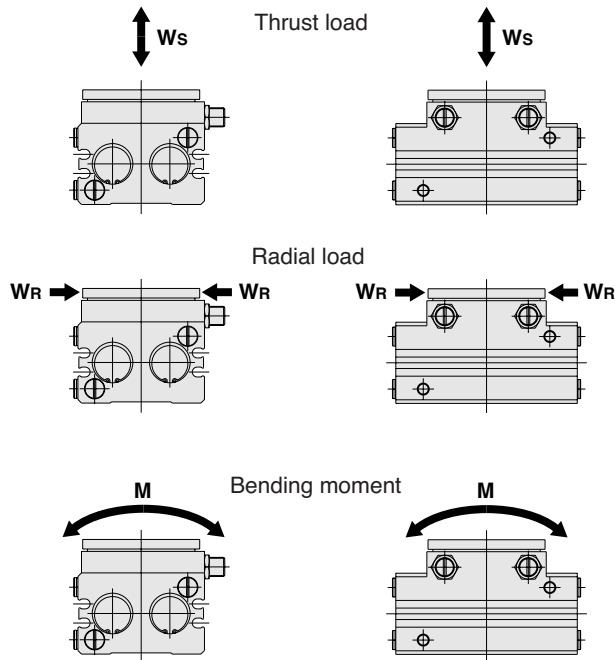
mm [in.]

Model	Cylinder bore	Cylinder stroke
RAT5-90	16 [0.63]	9.4 [0.37]
RAT5-180	16 [0.63]	18.8 [0.74]
RAT10-90	16 [0.63]	9.4 [0.37]
RAT10-180	16 [0.63]	18.8 [0.74]
RAT30-90	20 [0.79]	16.5 [0.65]
RAT30-180	20 [0.79]	33.0 [1.30]

Handling Instructions and Precautions

● Allowable load

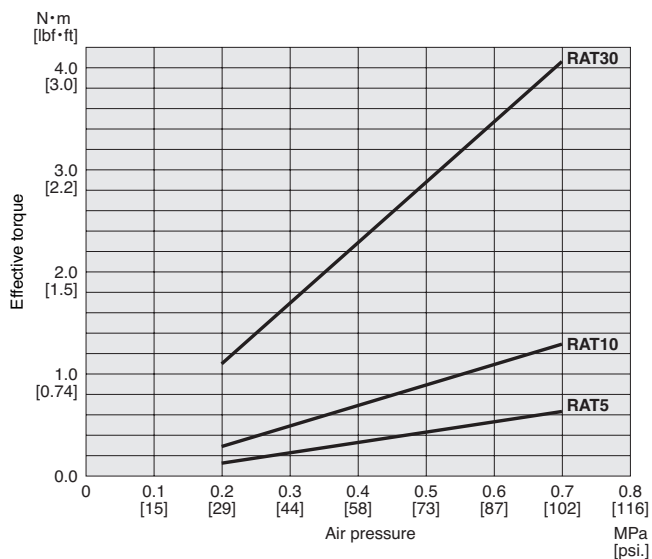
Item	Model	RAT5	RAT10	RAT30
Allowable thrust load W_s : N [lbf]		50 [11.2]	80 [18.0]	200 [45.0]
Allowable radial load W_R : N [lbf]		30 [6.7]	80 [18.0]	200 [45.0]
Allowable bending moment M : N·m [lbf·ft]		1.5 [1.1]	2.5 [1.8]	5.5 [4.1]



● Effective torque

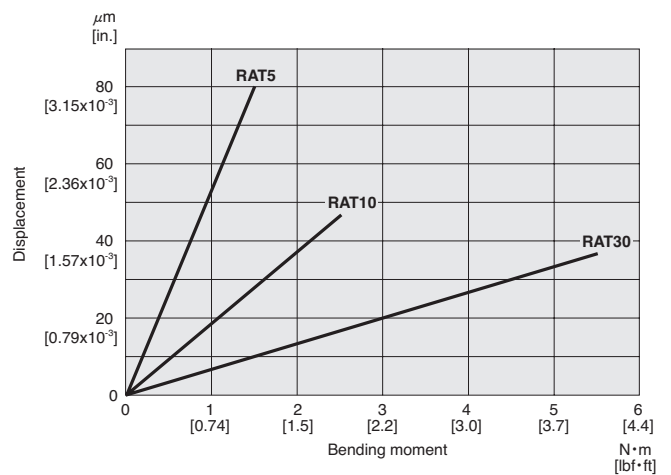
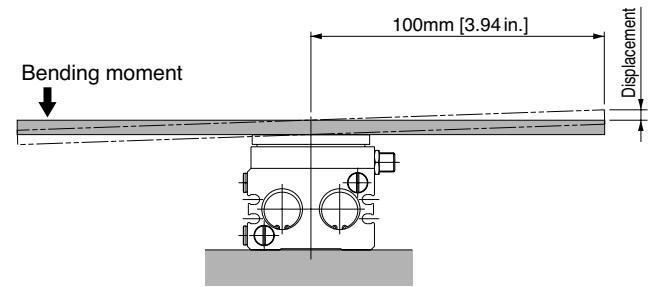
Model	Air pressure MPa [psi.]					N·m [lbf·ft]
	0.2 [29]	0.25 [36]	0.3 [44]	0.35 [51]	0.4 [58]	
RAT5	0.12 [0.09]	0.17 [0.13]	0.22 [0.16]	0.27 [0.20]	0.32 [0.24]	
RAT10	0.29 [0.21]	0.39 [0.29]	0.49 [0.36]	0.59 [0.44]	0.69 [0.51]	
RAT30	1.10 [0.81]	1.40 [1.03]	1.69 [1.25]	1.99 [1.47]	2.28 [1.68]	

Air pressure MPa [psi.]					
0.45 [65]	0.5 [73]	0.55 [80]	0.6 [87]	0.65 [94]	0.7 [102]
0.37 [0.27]	0.42 [0.31]	0.47 [0.35]	0.52 [0.38]	0.57 [0.42]	0.62 [0.46]
0.79 [0.58]	0.89 [0.66]	0.99 [0.73]	1.09 [0.80]	1.19 [0.88]	1.29 [0.95]
2.57 [1.90]	2.87 [2.12]	3.16 [2.33]	3.46 [2.55]	3.75 [2.77]	4.04 [2.98]



● Table displacement caused by bending moment

In the rotary actuator RAT series, mounting a plate and applying moment on it, and then measure the displacement at 100mm [3.94 in.] position from the rotation center.



Selection

Caution: For the load and swing time, follow the below “Model selection method” to select within the range of specified values. Moreover, about 80% of the allowable values is recommended to use in the application. By using these values, adverse effects on cylinders and guides can be a minimum.

● Model selection method

1. Check the application conditions

Check the following items ①~④

- ① Swing angle (90° or 180°)
- ② Swing time (s)
- ③ Applied pressure (MPa)
- ④ Load shape and materials
- ⑤ Mounting direction

2. Check the swing time

Check the swing time in 1—② is within the swing time adjustment range in the specification.

Angle	Swing time (s)
90°	0.2~1.0
180°	0.4~2.0

Note: The swing time value is derived by using the rubber stopper with no load at 0.5MPa condition.

3. Select torque size (select model)

Find the torque T_A required for rotating the body.

$$T_A = I \dot{\omega} K$$

T_A : Torque (N·m)
 I : Moment of inertia (kg·m²)
 Use the formulas on p.13~16 to find.
 $\dot{\omega}$: Equiangular acceleration (rad/s²)
 K : Marginal coefficient 5
 θ : Swing angle (rad)
 90°→1.57rad
 180°→3.14rad
 t : Swing time (s)

Select the model secures the required torque T_A by using the applied pressure checked in 1—③, from among the effective torque table or diagram on p.10.

4. Check the kinetic energy

If kinetic energy exceeds the allowable energy, the actuator could be damaged. Always select a model so that the energy remains within the allowable energy range. When the kinetic energy is large, use a model with shock absorber (-SS2, -SSR, or -SSL). For the allowable kinetic energy, see Table 1.

Find the kinetic energy.

● With rubber stopper

$$E = \frac{1}{2} \times I \times \omega^2$$

E : Kinetic energy (J)
 I : Moment of inertia (kg·m²)
 Use the formulas on p.13~16 to find.
 ω : Angular velocity (rad/s)
 θ : Swing angle (rad)
 90°→1.57rad
 180°→3.14rad
 t : Swing time (s)
 E_a : Allowable energy with rubber stopper
 ... See Table 1.

$$\omega = \frac{2\theta}{t}$$

$$E < E_a$$

● Model selection method

1. Check the application conditions

Check the following items ①~④

- ① Swing angle [90° or 180°]
- ② Swing time [s]
- ③ Applied pressure [psi.]
- ④ Load shape and materials
- ⑤ Mounting direction

2. Check the swing time

Check the swing time in 1—② is within the swing time adjustment range in the specification.

Angle	Swing time [s]
90°	0.2~1.0
180°	0.4~2.0

Note: The swing time value is derived by using the rubber stopper with no load at 73psi. condition.

3. Select torque size (select model)

Find the torque T_A' required for rotating the body.

$$T_A' = I' \dot{\omega} K$$

T_A' : Torque [lbf·ft]
 I' : Moment of inertia [lbf·ft·s²]
 Use the formulas on p.13~16 to find.
 $\dot{\omega}$: Equiangular acceleration [rad/s²]
 K : Marginal coefficient 5
 θ : Swing angle [rad]
 90°→1.57rad
 180°→3.14rad
 t : Swing time [s]

Select the model secures the required torque T_A' by using the applied pressure checked in 1—③, from among the effective torque table or diagram on p.10.

4. Check the kinetic energy

If kinetic energy exceeds the allowable energy, the actuator could be damaged. Always select a model so that the energy remains within the allowable energy range. When the kinetic energy is large, use a model with shock absorber (-SS2, -SSR, or -SSL). For the allowable kinetic energy, see Table 1.

Find the kinetic energy.

● With rubber stopper

$$E' = \frac{1}{2} \times I' \times \omega^2$$

E' : Kinetic energy [lbf·ft]
 I' : Moment of inertia [lbf·ft·s²]
 Use the formulas on p.13~16 to find.
 ω : Angular velocity [rad/s]
 θ : Swing angle [rad]
 90°→1.57rad
 180°→3.14rad
 t : Swing time [s]
 E_a' : Allowable energy with rubber stopper
 ... See Table 1.

$$\omega = \frac{2\theta}{t}$$

$$E' < E_a'$$

●With shock absorber

①Find the equivalent mass m_1 .

$$m_1 = \frac{I}{R^2}$$

m_1 : Equivalent mass (kg)
 I : Moment of inertia ($\text{kg} \cdot \text{m}^2$)

②Find the equivalent mass m_2 .

Use the formulas on p.13~16 to find.
 R : Distance from rotation center to impact point (m) ... See Fig.1 and Table 2.

$$m_2 = \frac{2 \times T \times L}{R^3 \times \omega^2}$$

m_2 : Equivalent mass (kg)

$$\omega = \frac{2\theta}{t}$$

T : Effective torque ($\text{N} \cdot \text{m}$)
 Use the effective torque table or diagram to find.

③Find the total mass m .

$$m = m_1 + m_2$$

L : Shock absorber stroke (m)
 ... See Table 2.

④Find the impact velocity.

$$V = R \times \omega$$

ω : Angular velocity (rad/s)
 θ : Swing angle (rad)
 $90^\circ \rightarrow 1.57\text{rad}$
 $180^\circ \rightarrow 3.14\text{rad}$

⑤Find the kinetic energy.

$$E = \frac{1}{2} \times m \times V^2$$

t : Swing time (s)
 m : Total mass (kg)
 V : Impact velocity (m/s)
 E : Kinetic energy (J)

$$E < E_a$$

E_a : Allowable energy with shock absorber ... See Table 1.

Table 1. Allowable energy E_a

Model	Allowable energy with rubber stopper (J)	Allowable energy with shock absorber (J)
RAT5	0.005	0.36
RAT10	0.008	0.53
RAT30	0.030	1.14

Fig.1 R: Distance from rotation center to impact point

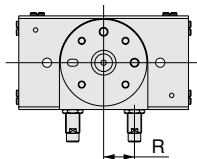


Table 2.

Model	Distance R from rotation center to impact point (m)	Shock absorber stroke L (m)	Shock absorber model
RAT5	0.0175	0.005	KSHAR5×5-D
RAT10	0.0175	0.005	KSHAR5×5-E
RAT30	0.0220	0.008	KSHAR6×8-F

5. Check the load ratio

Check that the total sum of the load ratio does not exceed 1.
 For the allowable load, see Table 3 (For the load direction, see the allowable load on p.10.)

$$\frac{W_s}{W_{s \text{ MAX}}} + \frac{W_R}{W_{R \text{ MAX}}} + \frac{M}{M_{\text{MAX}}} \leq 1$$

Table 3. Allowable load

Model	Thrust load $W_{s \text{ MAX}}$ (N)	Radial load $W_{R \text{ MAX}}$ (N)	Moment load M_{MAX} ($\text{N} \cdot \text{m}$)
RAT5	50	30	1.5
RAT10	80	80	2.5
RAT30	200	200	5.5

6. Judgement whether the unit is usable or not

The unit is usable if it satisfies both 4. Kinetic energy and 5. Load ratio.

$$E < E_a$$

$$\text{Total sum of load ratio} \leq 1$$

●With shock absorber

①Find the equivalent weight w_1 .

$$w_1 = \frac{I'}{R'^2} \times 32.2$$

w_1 : Equivalent weight [lb]
 I' : Moment of inertia [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

②Find the equivalent weight w_2 .

Use the formulas on p.13~16 to find.
 R' : Distance from rotation center to impact point [ft] ... See Fig.1 and Table 2.

$$w_2 = \frac{2 \times T' \times L' \times 32.2}{R'^3 \times \omega'^2}$$

w_2 : Equivalent weight [lb]

$$\omega = \frac{2\theta}{t}$$

T' : Effective torque [$\text{lb} \cdot \text{ft}$]
 Use the effective torque table or diagram to find.

③Find the total weight w .

$$w = w_1 + w_2$$

L' : Shock absorber stroke [ft]
 ... See Table 2.

④Find the impact velocity.

$$V' = R' \times \omega$$

ω : Angular velocity [rad/s]
 θ : Swing angle [rad]
 $90^\circ \rightarrow 1.57\text{rad}$
 $180^\circ \rightarrow 3.14\text{rad}$

⑤Find the kinetic energy.

$$E' = \frac{1}{2} \times \frac{w}{32.2} \times V'^2$$

t : Swing time [s]
 w : Total weight [lb]
 V' : Impact velocity [ft/s]
 E' : Kinetic energy [$\text{lb} \cdot \text{ft}$]

$$E' < E_a'$$

E_a' : Allowable energy with shock absorber ... See Table 1.

Table 1. Allowable energy E_a'

Model	Allowable energy with rubber stopper [$\text{lb} \cdot \text{ft}$]	Allowable energy with shock absorber [$\text{lb} \cdot \text{ft}$]
RAT5	0.004	0.266
RAT10	0.006	0.391
RAT30	0.022	0.841

Fig.1 R': Distance from rotation center to impact point

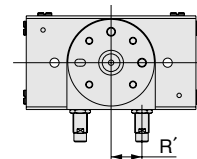


Table 2.

Model	Distance R' from rotation center to impact point [in.]	Shock absorber stroke L' [in.]	Shock absorber model
RAT5	0.69	0.20	KSHAR5×5-D
RAT10	0.69	0.20	KSHAR5×5-E
RAT30	0.87	0.31	KSHAR6×8-F

5. Check the load ratio

Check that the total sum of the load ratio does not exceed 1.
 For the allowable load, see Table 3 (For the load direction, see the allowable load on p.10.)

$$\frac{W_s}{W_{s \text{ MAX}}} + \frac{W_R}{W_{R \text{ MAX}}} + \frac{M}{M_{\text{MAX}}} \leq 1$$

Table 3. Allowable load

Model	Thrust load $W_{s \text{ MAX}}$ [lbf]	Radial load $W_{R \text{ MAX}}$ [lbf]	Moment load M_{MAX} [$\text{lb} \cdot \text{ft}$]
RAT5	11.2	6.7	1.1
RAT10	18.0	18.0	1.8
RAT30	45.0	45.0	4.1

6. Judgement whether the unit is usable or not

The unit is usable if it satisfies both 4. Kinetic energy and 5. Load ratio.

$$E' < E_a'$$

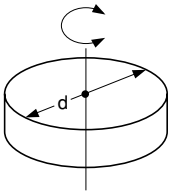
$$\text{Total sum of load ratio} \leq 1$$

Selection

Diagram for calculating moment of inertia

[When the rotating axis passes through the work]

Disk



● Diameter d (m)
● Mass m (kg)

■ Moment of inertia I ($\text{kg} \cdot \text{m}^2$)

$$I = \frac{md^2}{8}$$

■ Rotating radius

$$\frac{d^2}{8}$$

● Diameter d [ft]
● Weight w [lb]

■ Moment of inertia I' [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

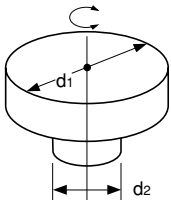
$$I' = \frac{wd^2}{8 \times 32.2}$$

■ Rotating radius

$$\frac{d^2}{8}$$

Remark: No particular mounting direction.
For sliding use, see separate materials.

Stepped disk



● Diameter d_1 (m)
 d_2 (m)
● Mass d_1 section m_1 (kg)
 d_2 section m_2 (kg)

■ Moment of inertia I ($\text{kg} \cdot \text{m}^2$)

$$I = \frac{1}{8} (m_1 d_1^2 + m_2 d_2^2)$$

■ Rotating radius

$$\frac{d_1^2 + d_2^2}{8}$$

● Diameter d_1 [ft]
 d_2 [ft]
● Weight d_1 section w_1 [lb]
 d_2 section w_2 [lb]

■ Moment of inertia I' [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

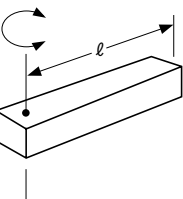
$$I' = \frac{1}{8 \times 32.2} \times (w_1 d_1^2 + w_2 d_2^2)$$

■ Rotating radius

$$\frac{d_1^2 + d_2^2}{8}$$

Remark: The d_2 section can be ignored when it is much smaller than the d_1 section.

Bar (rotation center is at edge)



● Bar length l (m)
● Mass m (kg)

■ Moment of inertia I ($\text{kg} \cdot \text{m}^2$)

$$I = \frac{m l^2}{3}$$

■ Rotating radius

$$\frac{l^2}{3}$$

● Bar length l [ft]
● Weight w [lb]

■ Moment of inertia I' [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

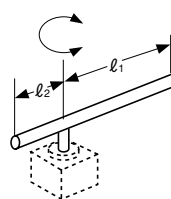
$$I' = \frac{w l^2}{3 \times 32.2}$$

■ Rotating radius

$$\frac{l^2}{3}$$

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.

Thin bar



● Bar length l_1 (m)
 l_2 (m)
● Mass m_1 (kg)
 m_2 (kg)

■ Moment of inertia I ($\text{kg} \cdot \text{m}^2$)

$$I = \frac{m_1 l_1^2}{3} + \frac{m_2 l_2^2}{3}$$

■ Rotating radius

$$\frac{l_1^2 + l_2^2}{3}$$

● Bar length l_1 [ft]
 l_2 [ft]
● Weight w_1 [lb]
 w_2 [lb]

■ Moment of inertia I' [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

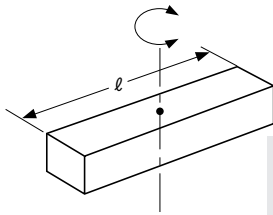
$$I' = \frac{w_1 l_1^2}{3 \times 32.2} + \frac{w_2 l_2^2}{3 \times 32.2}$$

■ Rotating radius

$$\frac{l_1^2 + l_2^2}{3}$$

Remark: Mounting direction is horizontal.
If the mounting direction is vertical, the swing time will change.

● Bar (rotation center is through the center of gravity)



- Bar length ℓ (m)
- Mass m (kg)

- Moment of inertia I ($\text{kg} \cdot \text{m}^2$)

$$I = \frac{m \ell^2}{12}$$

- Rotating radius

$$\frac{\ell^2}{12}$$

- Bar length ℓ [ft]
- Weight w [lb]

- Moment of inertia I' [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

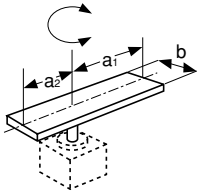
$$I' = \frac{w \ell^2}{12 \times 32.2}$$

- Rotating radius

$$\frac{\ell^2}{12}$$

Remark: No particular mounting direction.

● Thin rectangular plate (rectangular solid)



- Plate length a_1 (m)
- a_2 (m)
- Length of side b (m)
- Mass m_1 (kg)
- m_2 (kg)

- Moment of inertia I ($\text{kg} \cdot \text{m}^2$)

$$I = \frac{m_1}{12} (4a_1^2 + b^2) + \frac{m_2}{12} (4a_2^2 + b^2)$$

- Rotating radius

$$\frac{(4a_1^2 + b^2) + (4a_2^2 + b^2)}{12}$$

- Plate length a_1 [ft]
- a_2 [ft]
- Length of side b [ft]
- Weight w_1 [lb]
- w_2 [lb]

- Moment of inertia I' [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

$$I' = \frac{w_1}{12 \times 32.2} (4a_1^2 + b^2) + \frac{w_2}{12 \times 32.2} (4a_2^2 + b^2)$$

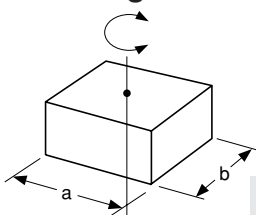
- Rotating radius

$$\frac{(4a_1^2 + b^2) + (4a_2^2 + b^2)}{12}$$

Remark: Mounting direction is horizontal.

If the mounting direction is vertical, the swing time will change.

● Rectangular solid



- Plate length a (m)
- b (m)
- Mass m (kg)

- Moment of inertia I ($\text{kg} \cdot \text{m}^2$)

$$I = \frac{m}{12} (a^2 + b^2)$$

- Rotating radius

$$\frac{a^2 + b^2}{12}$$

- Plate length a [ft]
- b [ft]
- Weight w [lb]

- Moment of inertia I' [$\text{lb} \cdot \text{ft} \cdot \text{s}^2$]

$$I' = \frac{w}{12 \times 32.2} (a^2 + b^2)$$

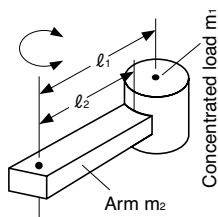
- Rotating radius

$$\frac{a^2 + b^2}{12}$$

Remark: No particular mounting direction.

For sliding use, see separate materials.

Concentrated load



- Shape of concentrated load
- Distance to center of gravity of concentrated load ℓ_1 (m)
- Length of arm ℓ_2 (m)
- Mass of concentrated load m_1 (kg)
- Mass of arm m_2 (kg)

■ Moment of inertia I (kg·m²)

$$I = m_1 k^2 + m_1 \ell_1^2 + \frac{m_2 \ell_2^2}{3}$$

Rotating radius: k^2 is calculated according to shape of the concentrated load.

Remark: Mounting direction is horizontal. When m_2 is much smaller than m_1 , calculate as $m_2 = 0$.

- Shape of concentrated load
- Distance to center of gravity of concentrated load ℓ_1 [ft]
- Length of arm ℓ_2 [ft]
- Weight of concentrated load w_1 [lb]
- Weight of arm w_2 [lb]

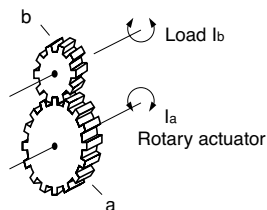
■ Moment of inertia I' [lbf·ft·s²]

$$I' = \frac{w_1 k^2}{32.2} + \frac{w_1 \ell_1^2}{32.2} + \frac{w_2}{32.2} \times \frac{\ell_2^2}{3}$$

Rotating radius: k^2 is calculated according to shape of the concentrated load.

Remark: Mounting direction is horizontal. When w_2 is much smaller than w_1 , calculate as $w_2 = 0$.

Gear Equation for calculating the load J_L about the rotary actuator axis when transmitted by gear



- Gear Rotary actuator side a
- Load side b
- Inertia moment of load I_a N·m

■ Moment of inertia I (kg·m²)

Inertia moment of load around rotating axis

$$I_a = \left(\frac{a}{b} \right)^2 I_b$$

- Gear Rotary actuator side a
- Load side b
- Inertia moment of load I_a lbf·ft

■ Moment of inertia I' [lbf·ft·s²]

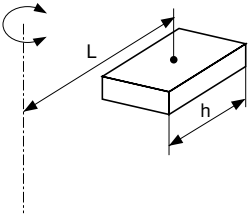
Inertia moment of load around rotating axis

$$I_a = \left(\frac{a}{b} \right)^2 I_b$$

Remark: If the shape of the gear is too large, the inertia moment of the gear must be also taken into consideration.

[When the rotating axis is offset from the work]

● Rectangular solid



- Length of side h (m)
- Length from rotating axis to the center of load L (m)
- Mass m (kg)

■ Moment of inertia I (kg·m²)

$$I = \frac{mh^2}{12} + mL^2$$

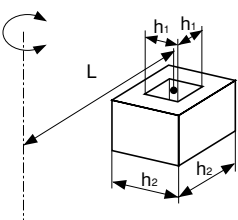
- Length of side h [ft]
- Length from rotating axis to the center of load L [ft]
- Weight w [lb]

■ Moment of inertia I' [lbf·ft·s²]

$$I' = \frac{wh^2}{32.2 \times 12} + \frac{wL^2}{32.2}$$

Remark: Same for cubical body.

● Hollow rectangular solid



- Length of side h₁ (m)
- Length from rotating axis to the center of load L (m)
- Mass m (kg)

■ Moment of inertia I (kg·m²)

$$I = \frac{m}{12} (h_2^2 + h_1^2) + mL^2$$

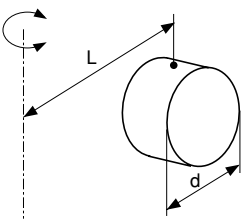
- Length of side h₁ [ft]
- Length from rotating axis to the center of load L [ft]
- Weight w [lb]

■ Moment of inertia I' [lbf·ft·s²]

$$I' = \frac{w(h_2^2 + h_1^2)}{32.2 \times 12} + \frac{wL^2}{32.2}$$

Remark: Cross-section is for cubic body only.

● Cylinder



- Diameter d (m)
- Length from rotating axis to the center of load L (m)
- Mass m (kg)

■ Moment of inertia I (kg·m²)

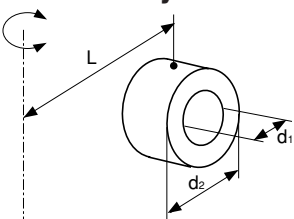
$$I = \frac{md^2}{16} + mL^2$$

- Diameter d [ft]
- Length from rotating axis to the center of load L [ft]
- Weight w [lb]

■ Moment of inertia I' [lbf·ft·s²]

$$I' = \frac{wd^2}{32.2 \times 16} + \frac{wL^2}{32.2}$$

● Hollow cylinder



- Diameter d₁ (m)
- Length from rotating axis to the center of load L (m)
- Mass m (kg)

■ Moment of inertia I (kg·m²)

$$I = \frac{m}{16} (d_2^2 + d_1^2) + mL^2$$

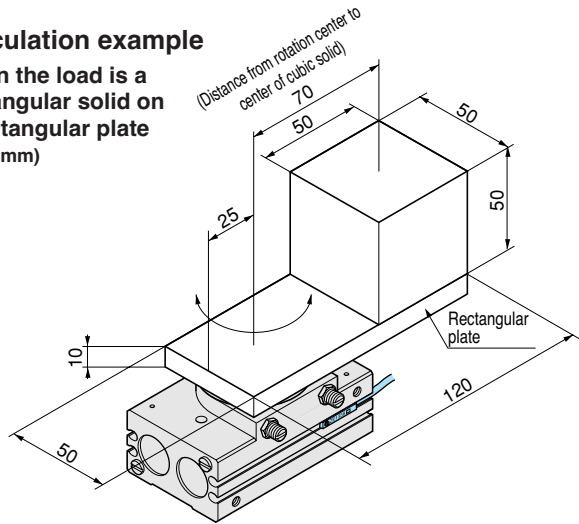
- Diameter d₁ [ft]
- Length from rotating axis to the center of load L [ft]
- Weight w [lb]

■ Moment of inertia I' [lbf·ft·s²]

$$I' = \frac{w(d_2^2 + d_1^2)}{32.2 \times 16} + \frac{wL^2}{32.2}$$

● Calculation example

When the load is a rectangular solid on a rectangular plate
(unit: mm)



1. Check application conditions

- ① Swing angle : 90°
- ② Swing time : 0.5 (s)
- ③ Applied pressure : 0.5 (MPa)
- ④ Load shape: Shown in the above
Load material
Rectangular plate: Aluminum alloy (Specific gravity = $2.68 \times 10^3 \text{ kg/m}^3$)
Rectangular solid: Steel (Specific gravity = $7.85 \times 10^3 \text{ kg/m}^3$)
- ⑤ Mounting direction : Horizontal

2. Check the swing time

The swing time is 0.5s/90°, which is within the range of 0.2~1.0s/90°, and is therefore not a problem.

3. Select by the torque

Firstly calculate the moment of inertia.

Rectangular plate

$$m_1 = 0.05 \times (0.12 - 0.025) \times 0.01 \times 2.68 \times 10^3 = 0.127 \text{ (kg)}$$

$$m_2 = 0.05 \times 0.025 \times 0.01 \times 2.68 \times 10^3 = 0.034 \text{ (kg)}$$

$$I_1 = \frac{0.127}{12} \{4 \times (0.12 - 0.025)^2 + 0.05^2\} + \frac{0.034}{12} \{4 \times 0.025^2 + 0.05^2\}$$

$$= 0.42 \times 10^{-3} \text{ (kg} \cdot \text{m}^2) \cdots \text{①}$$

Rectangular solid

$$m_3 = 0.05 \times 0.05 \times 0.05 \times 7.85 \times 10^3 = 0.981 \text{ (kg)}$$

$$I_2 = \frac{0.981 \times 0.05^2}{12} + 0.981 \times 0.07^2$$

$$= 5.01 \times 10^{-3} \text{ (kg} \cdot \text{m}^2) \cdots \text{②}$$

From ① and ②, the total moment of inertia I is

$$I = I_1 + I_2$$

$$= 0.42 \times 10^{-3} + 5.01 \times 10^{-3}$$

$$= 5.43 \times 10^{-3} \text{ (kg} \cdot \text{m}^2) \cdots \text{③}$$

According to the conditions, $\theta = 90^\circ$, $t = 0.5 \text{ (s)}$
therefore, the equiangular acceleration $\dot{\omega}$ is

$$\dot{\omega} = \frac{2 \times 1.57}{0.5^2} = 12.56 \text{ (rad/s}^2) \cdots \text{④}$$

From ③ and ④, the required torque T_A is

$$T_A = 5.43 \times 10^{-3} \times 12.56 \times 5$$

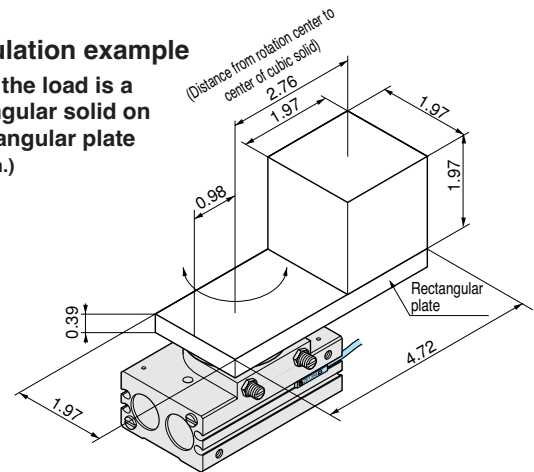
$$= 0.341 \text{ (N} \cdot \text{m)} \cdots \text{⑤}$$

From the Effective Torque Table (diagram), select a model where the torque is more than 0.341 (N·m) at 0.5 MPa.

RAT5-90

● Calculation example

When the load is a rectangular solid on a rectangular plate
(unit: in.)



1. Check application conditions

- ① Swing angle : 90°
- ② Swing time : 0.5 [s]
- ③ Applied pressure : 73 [psi.]
- ④ Load shape: Shown in the above
Load material
Rectangular plate: Aluminum alloy (Specific gravity = 167 lb/ft³)
Rectangular solid: Steel (Specific gravity = 490 lb/ft³)
- ⑤ Mounting direction : Horizontal

2. Check the swing time

The swing time is 0.5s/90°, which is within the range of 0.2~1.0s/90°, and is therefore not a problem.

3. Select by the torque

Firstly calculate the moment of inertia.

Rectangular plate

$$w_1 = \frac{1.97}{12} \times \frac{(4.72 - 0.98)}{12} \times \frac{0.39}{12} \times 167 = 0.278 \text{ [lb]}$$

$$w_2 = \frac{1.97}{12} \times \frac{0.98}{12} \times \frac{0.39}{12} \times 167 = 0.073 \text{ [lb]}$$

$$I_1' = \frac{0.278}{12 \times 32.2} \left\{ 4 \times \left(\frac{4.72 - 0.98}{12} \right)^2 + \left(\frac{1.97}{12} \right)^2 \right\} + \frac{0.073}{12 \times 32.2} \left\{ 4 \times \left(\frac{0.98}{12} \right)^2 + \left(\frac{1.97}{12} \right)^2 \right\}$$

$$= 0.31 \times 10^{-3} \text{ [lb} \cdot \text{ft} \cdot \text{s}^2] \cdots \text{①}$$

Rectangular solid

$$w_3 = \frac{1.97}{12} \times \frac{1.97}{12} \times \frac{1.97}{12} \times 490 = 2.17 \text{ [lb]}$$

$$I_2' = \frac{2.17}{12 \times 32.2} \times \left(\frac{1.97}{12} \right)^2 + \frac{2.17}{32.2} \times \left(\frac{2.76}{12} \right)^2$$

$$= 3.71 \times 10^{-3} \text{ [lb} \cdot \text{ft} \cdot \text{s}^2] \cdots \text{②}$$

From ① and ②, the total moment of inertia I' is

$$I' = I_1' + I_2'$$

$$= 0.31 \times 10^{-3} + 3.71 \times 10^{-3}$$

$$= 4.02 \times 10^{-3} \text{ [lb} \cdot \text{ft} \cdot \text{s}^2] \cdots \text{③}$$

According to the conditions, $\theta = 90^\circ$, $t = 0.5 \text{ [s]}$
therefore, the equiangular acceleration $\dot{\omega}$ is

$$\dot{\omega} = \frac{2 \times 1.57}{0.5^2} = 12.56 \text{ [rad/s}^2] \cdots \text{④}$$

From ③ and ④, the required torque T_A' is

$$T_A' = 4.02 \times 10^{-3} \times 12.56 \times 5$$

$$= 0.252 \text{ [lb} \cdot \text{ft]} \cdots \text{⑤}$$

From the Effective Torque Table (diagram), select a model where the torque is more than 0.252 [lb·ft] at 73 psi.

RAT5-90

4. Check the kinetic energy

With rubber stopper

According to the conditions, $\theta=90^\circ$, $t=0.5$ (s)
therefore,

$$\omega = \frac{2 \times 1.57}{0.5} = 6.28 \text{ (rad/s)} \cdots \textcircled{1}$$

From ①, kinetic energy E is

$$E = \frac{1}{2} \times 5.43 \times 10^{-3} \times 6.28^2 = 0.107 \text{ (J)} \cdots \textcircled{2}$$

$0.107 > 0.005$, which means the rubber stopper is not sufficient.
Therefore, recalculate with shock absorber.

With shock absorber

$$m_1 = \frac{5.43 \times 10^{-3}}{0.0175^2} = 17.73 \text{ (kg)} \cdots \textcircled{3}$$

$$m_2 = \frac{2 \times 0.42 \times 0.005}{0.0175^3 \times 6.28^2} = 19.87 \text{ (kg)} \cdots \textcircled{4}$$

From ③ and ④,

$$m = 17.73 + 19.87 = 37.60 \text{ (kg)} \cdots \textcircled{5}$$

$$V = 0.0175 \times 6.28 = 0.110 \cdots \textcircled{6}$$

From ⑤ and ⑥, find the kinetic energy.

$$E = \frac{1}{2} \times 37.60 \times 0.110^2 = 0.227 \text{ (J)}$$

$0.227 < 0.36$, which means there is no problem in the application with shock absorber.

5. Check the load

【Thrust load】

The total mass is

$$0.034 + 0.127 + 0.981 = 1.142 \text{ (kg)}$$

Therefore,

$$W_s = 1.142 \times 9.8 = 11.192 \text{ (N)} \cdots \textcircled{1}$$

【Radial load】

Since no radial load is applied,

$$W_R = 0 \text{ (N)} \cdots \textcircled{2}$$

【Moment】

The moment by the rectangular plate M₁ is

$$M_1 = (0.034 + 0.127) \times 9.8 \times \left(\frac{0.12}{2} - 0.025 \right) = 0.055 \text{ (N} \cdot \text{m)} \cdots \textcircled{3}$$

The moment by the rectangular solid M₂ is

$$M_2 = 0.981 \times 9.8 \times 0.07 = 0.673 \text{ (N} \cdot \text{m)} \cdots \textcircled{4}$$

From ③ and ④, the total moment is

$$M = 0.055 + 0.673 = 0.728 \text{ (N} \cdot \text{m)} \cdots \textcircled{5}$$

From ①, ②, and ⑤, find the load ratio

$$\frac{W_s}{W_{s \text{ MAX}}} + \frac{W_R}{W_{R \text{ MAX}}} + \frac{M}{M_{\text{MAX}}} = \frac{11.192}{50} + \frac{0}{30} + \frac{0.728}{1.5} = 0.71 < 1.0$$

and the load ratio is less than 1.0, which means there is no problem.

6. Check the unit specifications

Selection of **RAT5-90-SS2** satisfies both the kinetic energy and load ratio requirements.

4. Check the kinetic energy

With rubber stopper

According to the conditions, $\theta=90^\circ$, $t=0.5$ [s]
therefore,

$$\omega = \frac{2 \times 1.57}{0.5} = 6.28 \text{ [rad/s]} \cdots \textcircled{1}$$

From ①, kinetic energy E' is

$$E' = \frac{1}{2} \times 4.02 \times 10^{-3} \times 6.28^2 = 0.0793 \text{ [lbf} \cdot \text{ft]} \cdots \textcircled{2}$$

$0.0793 > 0.004$, which means the rubber stopper is not sufficient.
Therefore, recalculate with shock absorber.

With shock absorber

$$w_1 = \frac{4.02 \times 10^{-3} \times 32.2}{\left(\frac{0.69}{12} \right)^2} = 39.15 \text{ [lb]} \cdots \textcircled{3}$$

$$w_2 = \frac{2 \times 0.31 \times \frac{0.2}{12} \times 32.2}{\left(\frac{0.69}{12} \right)^3 \times 6.28^2} = 44.38 \text{ [lb]} \cdots \textcircled{4}$$

From ③ and ④,

$$w = 39.15 + 44.38 = 83.53 \text{ [lb]} \cdots \textcircled{5}$$

$$V' = \frac{0.69}{12} \times 6.28 = 0.361 \cdots \textcircled{6}$$

From ⑤ and ⑥, find the kinetic energy.

$$E' = \frac{83.53 \times 0.361^2}{2 \times 32.2} = 0.169 \text{ [lbf} \cdot \text{ft]}$$

$0.169 < 0.27$, which means there is no problem in the application with shock absorber.

5. Check the load

【Thrust load】

The total weight is

$$0.278 + 0.073 + 2.17 = 2.52 \text{ [lb]}$$

Therefore,

$$W_s = 2.52 \text{ [lb]} \cdots \textcircled{1}$$

【Radial load】

Since no radial load is applied,

$$W_R = 0 \text{ [lb]} \cdots \textcircled{2}$$

【Moment】

The moment by the rectangular plate M₁ is

$$M_1 = (0.073 + 0.278) \times \left(\frac{1}{2} \times \frac{4.72}{12} - \frac{0.98}{12} \right) = 0.040 \text{ [lbf} \cdot \text{ft]} \cdots \textcircled{3}$$

The moment by the rectangular solid M₂ is

$$M_2 = 2.17 \times \frac{2.76}{12} = 0.499 \text{ [lbf} \cdot \text{ft]} \cdots \textcircled{4}$$

From ③ and ④, the total moment is

$$M = 0.040 + 0.499 = 0.539 \text{ [lbf} \cdot \text{ft]} \cdots \textcircled{5}$$

From ①, ②, and ⑤, find the load ratio

$$\frac{W_s}{W_{s \text{ MAX}}} + \frac{W_R}{W_{R \text{ MAX}}} + \frac{M}{M_{\text{MAX}}} = \frac{2.52}{11.2} + \frac{0}{6.7} + \frac{0.539}{1.1} = 0.715 < 1.0$$

and the load ratio is less than 1.0, which means there is no problem.

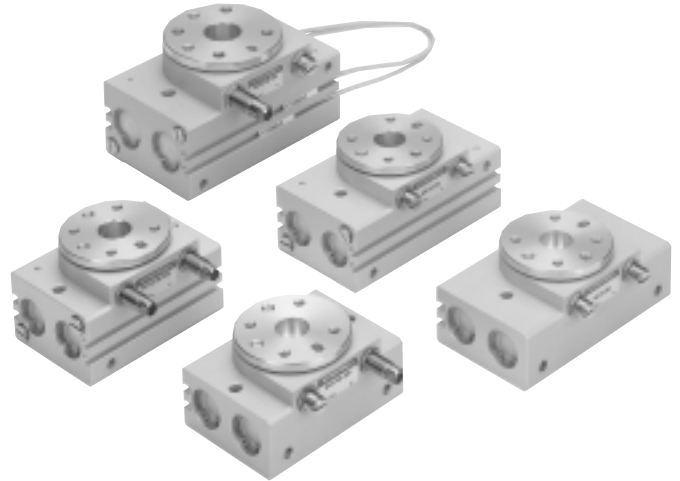
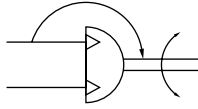
6. Check the unit specifications

Selection of **RAT5-90-SS2** satisfies both the kinetic energy and load ratio requirements.

ROTARY ACTUATORS

RAT Series

Symbol



Specifications

Item		Model	RAT5	RAT10	RAT30
Operation			Double acting single piston type (rack and pinion method)	Double acting double piston type (rack and pinion method)	
Effective torque ^{Note 1}		N·m{kgf·m} [lbf·ft]	0.42 {0.043} [0.31]	0.89 {0.091} [0.66]	2.87 {0.293} [2.12]
Media			Air		
Operating pressure range		MPa{kgf/cm ² } [psi.]	0.2~0.7 {2~7.1} [29~102]		
Proof pressure		MPa{kgf/cm ² } [psi.]	1.05 {10.7} [152]		
Operating temperature range		°C [°F]	0~60 [32~140]		
Cushion	With rubber stopper		Rubber bumper		
	With shock absorber		Shock absorber		
Swing angle range	90° type		— 5°~95°		
	180° type		— 5°~185°		
Swing angle adjustment range ^{Note 2}	90° type		Clockwise rotation end: ±5° referred to 0° position/Counterclockwise rotation end: ±5° referred to 90° position		
	180° type		Clockwise rotation end: ±5° referred to 0° position/Counterclockwise rotation end: ±5° referred to 180° position		
Swing time adjustment range ^{Note 3}		s/90°	0.2~1.0		
Allowable energy J{kgf·m} [lbf·ft]	With rubber stopper		0.005 {0.0005} [0.004]	0.008 {0.0008} [0.006]	0.03 {0.003} [0.022]
	With shock absorber		0.36 {0.037} [0.27]	0.53 {0.054} [0.39]	1.14 {0.116} [0.841]
Allowable thrust load		N{kgf} [lbf]	50 {5.1} [11]	80 {8.1} [18]	200 {20.4} [45]
Allowable radial load		N{kgf} [lbf]	30 {3.1} [6.7]	80 {8.1} [18]	200 {20.4} [45]
Allowable bending moment		N·m{kgf·m} [lbf·ft]	1.5 {0.15} [1.1]	2.5 {0.25} [1.8]	5.5 {0.56} [4.1]
Lubrication			Not needed (If lubrication must be used, use turbine oil Class 1 (ISO VG32) or its equivalent)		
Port size			M5×0.8		

Notes: 1. Effective torque is the value when the pressure is 0.5 MPa [73 psi].

2. For the swing end position, see p.23.

3. The swing time adjustment range is the value by using rubber stopper option, at no load and pressure of 0.5 MPa [73 psi].

Shock Absorber Specifications

Item		Model	KSHAR5×5-D	KSHAR5×5-E	KSHAR6×8-F
Applicable model			RAT5	RAT10	RAT30
Maximum absorption		J{kgf·m} [lbf·ft]	1.0 {0.1} [0.7]	2.0 {0.2} [1.5]	3.0 {0.3} [2.2]
Absorption stroke		mm [in.]	5 [0.2]		8 [0.3]
Maximum operating frequency		cycle/min	60		30
Maximum impact speed		mm/s [in./s]	300 [11.8]		
Angle variation		°	8 or less		12 or less
Operating temperature range		°C [°F]	0~60 [32~140]		

Caution: Even if applications are within the shock absorber absorption range, follow also within the rotary actuator RAT series swing time adjustment and allowable energy range.

Remarks: 1. Do not loosen or remove the small screw on the back end surface of the shock absorber. Oil enclosed inside could leak out and damage shock absorber performance.

2. Depending on usage conditions, the shock absorber's life may vary from the rotary actuator RAT series body's life.

Order Code

RAT - - -

Number of sensor switches

- 1 : With 1 switch
2 : With 2 switches
⋮
n : With n switches

Lead wire length

- A : 1000mm [39 in.]
B : 3000mm [118 in.]

Type of sensor switch

- Blank** : Without sensor switch
ZE101 : Reed switch type, without indicator lamp
ZE102 : Reed switch type, with indicator lamp
ZE201 : Reed switch type, without indicator lamp
ZE202 : Reed switch type, with indicator lamp
ZE135 : 2-lead wires solid state type, with indicator lamp
ZE155 : 3-lead wires solid state type, with indicator lamp
ZE235 : 2-lead wires solid state type, with indicator lamp
ZE255 : 3-lead wires solid state type, with indicator lamp
● For details about sensor switches, see p.28.

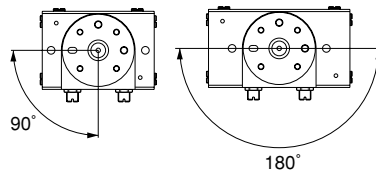
Horizontal lead wire	DC5~28V, AC85~115V
Horizontal lead wire	DC10~28V, AC85~115V
Vertical lead wire ^{Note3}	DC5~28V, AC85~115V
Vertical lead wire ^{Note3}	DC10~28V, AC85~115V
Horizontal lead wire	DC10~28V
Horizontal lead wire	DC4.5~28V
Vertical lead wire ^{Note3}	DC10~28V
Vertical lead wire ^{Note3}	DC4.5~28V

Angle adjustment mechanism

- Blank** : With rubber stopper on both sides
SS2 : With shock absorber on both sides
SSR : With shock absorber on right side (Clockwise rotation end side)^{Note 2}
SSL : With shock absorber on left side (Counterclockwise rotation end side)^{Note 2}

Swing angle

- 90 : 90°
180 : 180°



Nominal torque

- 5 : 0.42N·m [0.31lbf·ft]
10 : 0.89N·m [0.66lbf·ft]
30 : 2.87N·m [2.12lbf·ft]

Notes: 1. Standard, with magnet type.

2. The opposite side of the shock absorber unit (SSR or SSL) comes with rubber stopper.

3. The vertical lead wire type is lead wire runs out from the perpendicular direction of the sensor switch.

Basic model

Rotary actuator RAT series

Mass

g [lb]

Model	Mass
RAT5-90	285 [0.628]
RAT5-90-SS2	285 [0.628]
RAT5-90-SSR (L)	285 [0.628]
RAT5-180	340 [0.750]
RAT5-180-SS2	340 [0.750]
RAT5-180-SSR (L)	340 [0.750]
RAT10-90	350 [0.772]
RAT10-90-SS2	350 [0.772]
RAT10-90-SSR (L)	350 [0.772]
RAT10-180	420 [0.926]
RAT10-180-SS2	420 [0.926]
RAT10-180-SSR (L)	420 [0.926]
RAT30-90	690 [1.52]
RAT30-90-SS2	694 [1.53]
RAT30-90-SSR (L)	692 [1.53]
RAT30-180	855 [1.88]
RAT30-180-SS2	859 [1.89]
RAT30-180-SSR (L)	857 [1.89]
CRK588	10 [0.022]
CRK589	20 [0.044]
KSHAR5×5-D	10 [0.022]
KSHAR5×5-E	10 [0.022]
KSHAR6×8-F	22 [0.049]

Additional Parts

●Rubber stopper

CRK

588 : For RAT5-□, For RAT10-□

589 : For RAT30-□

●Shock absorber

KSHAR

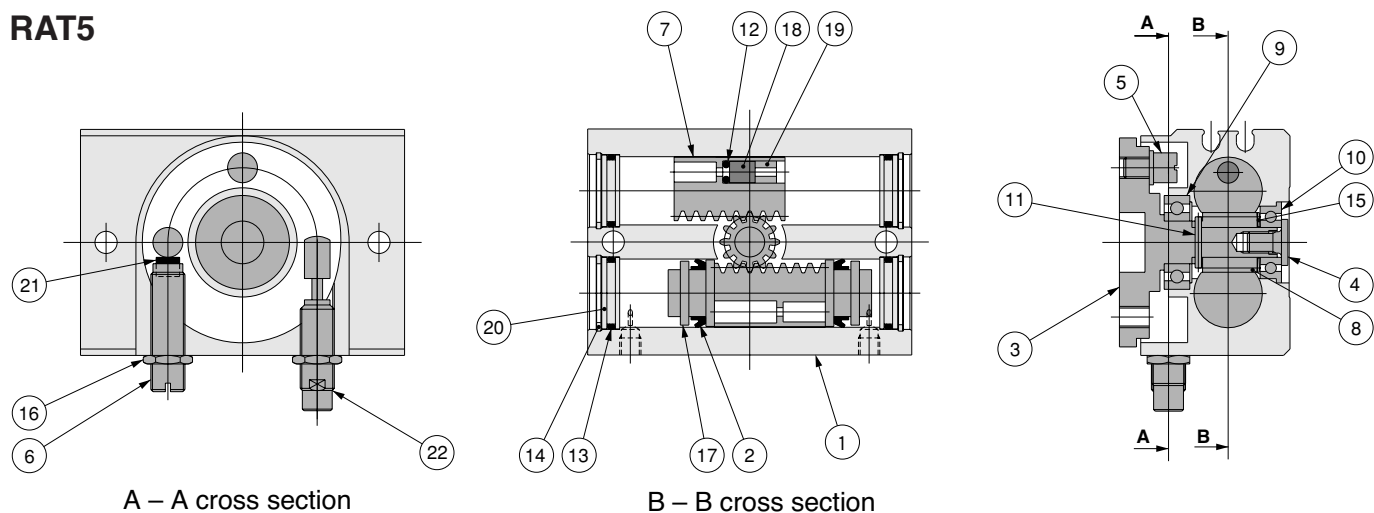
5×5-D : For RAT5-□

5×5-E : For RAT10-□

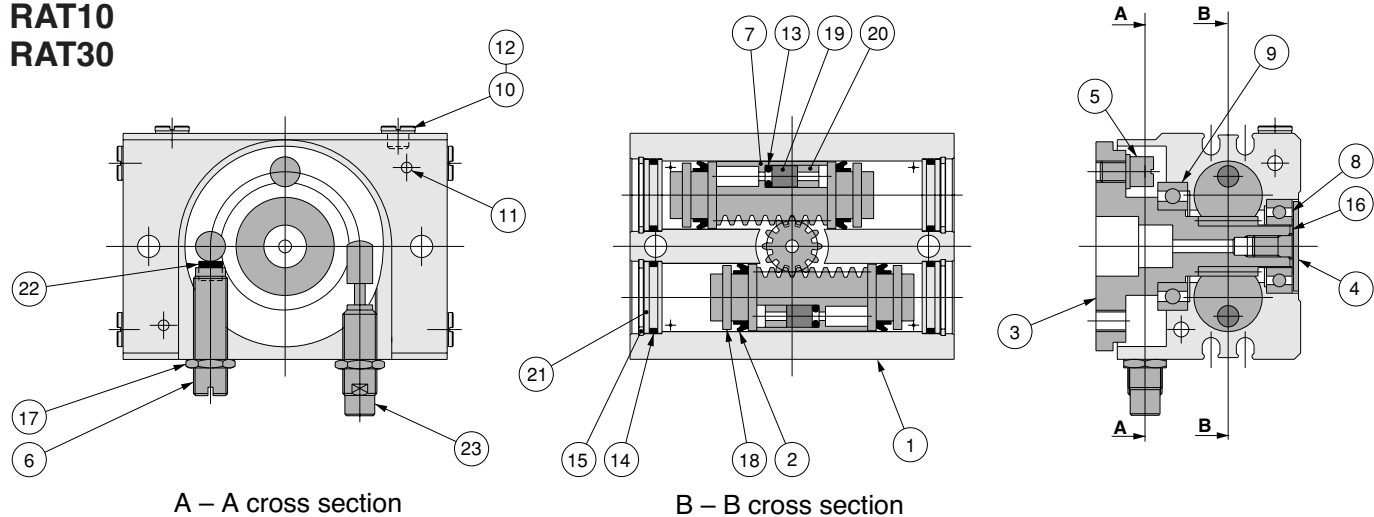
6×8-F : For RAT30-□

Remark: The shock absorber or rubber stopper come as a set consisting of its body and one mounting nut.

RAT5



RAT10 RAT30



Major Parts and Materials

RAT5

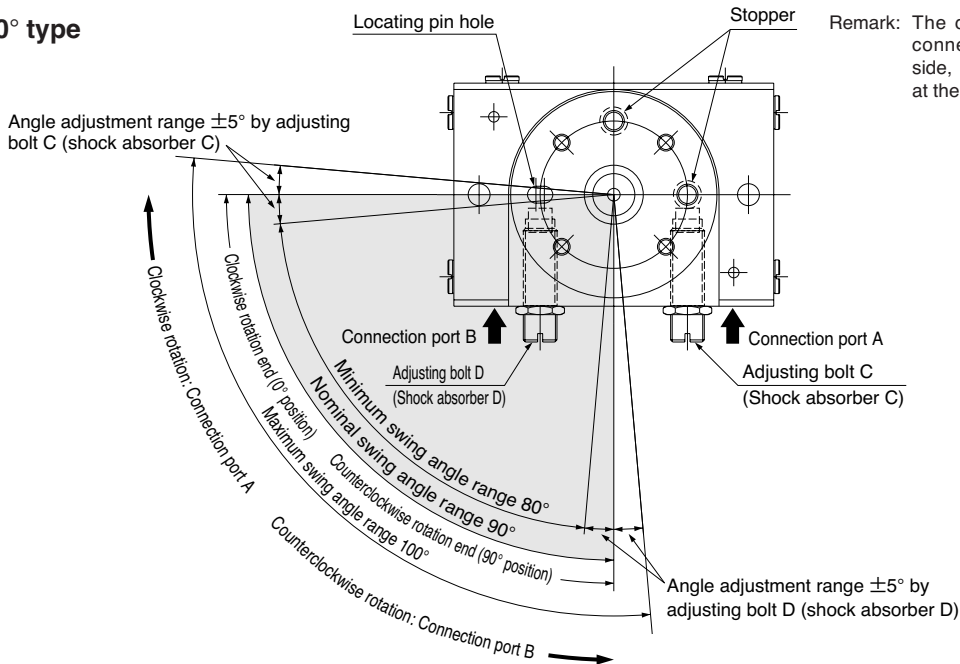
No	Parts	Materials
①	Body	Aluminum alloy (anodized)
②	Piston seal	Synthetic rubber (NBR)
③	Table	Aluminum alloy (anodized)
④	Table holding screw	Stainless steel
⑤	Stopper	Special steel
⑥	Adjusting bolt	Steel (nickel plated)
⑦	Rack	Plastic
⑧	Spur gear	Steel
⑨	Bearing	Steel
⑩	Bearing	Steel
⑪	Spring pin	Steel
⑫	O ring	Synthetic rubber (NBR)
⑬	O ring	Synthetic rubber (NBR)
⑭	Snap ring	Steel (nickel plated)
⑮	Washer	Steel
⑯	Hexagonal nut	Mild steel (zinc plated)
⑰	Piston	Plastic
⑱	Magnet	Plastic magnet
⑲	Magnet holder	Plastic
⑳	End plate	Plastic
㉑	Bumper	Synthetic rubber (NBR)
㉒	Shock absorber	—

RAT10 RAT30

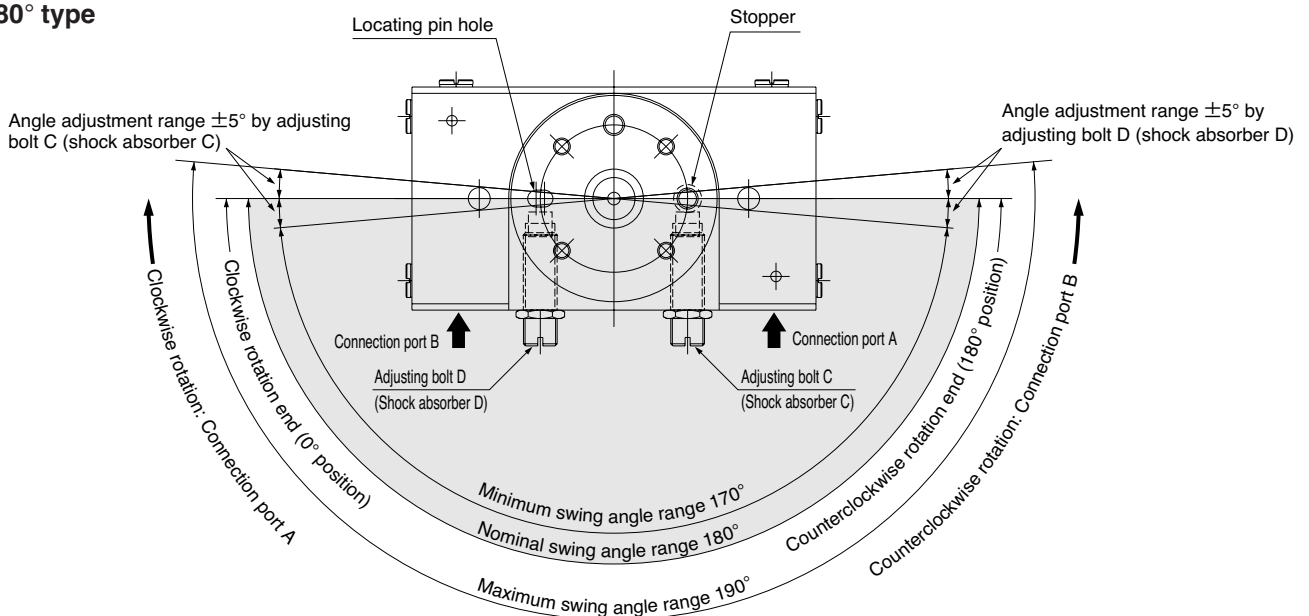
No	Parts	Materials
①	Body	Aluminum alloy (anodized)
②	Piston seal	Synthetic rubber (NBR)
③	Table	Aluminum alloy (anodized)
④	Table holding screw	Stainless steel
⑤	Stopper	Special steel
⑥	Adjusting bolt	Steel (nickel plated)
⑦	Rack	Plastic
⑧	Bearing	Steel
⑨	Bearing	Steel
⑩	Plug	Mild steel (nickel plated)
⑪	Steel ball	Special steel
⑫	Seal	Mild steel + Synthetic rubber (NBR)
⑬	O ring	Synthetic rubber (NBR)
⑭	O ring	Synthetic rubber (NBR)
⑮	Snap ring	Steel (nickel plated)
⑯	Washer	Steel
⑰	Hexagonal nut	Mild steel (zinc plated)
⑱	Piston	Plastic
⑲	Magnet	Plastic magnet
⑳	Magnet holder	Plastic
㉑	End plate	Plastic
㉒	Bumper	Synthetic rubber (NBR)
㉓	Shock absorber	—

Swing Angle Range and Swing Direction

90° type



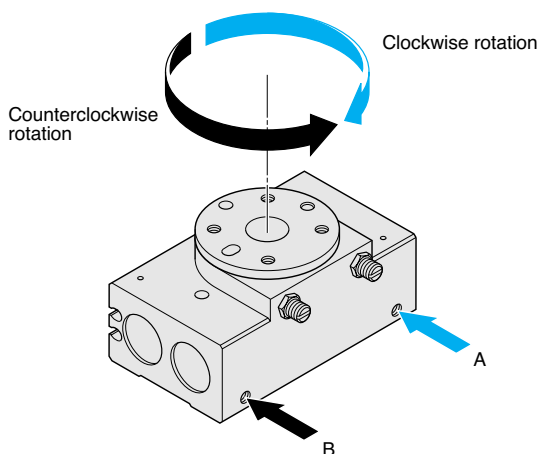
180° type



Piping Location and Swing Direction

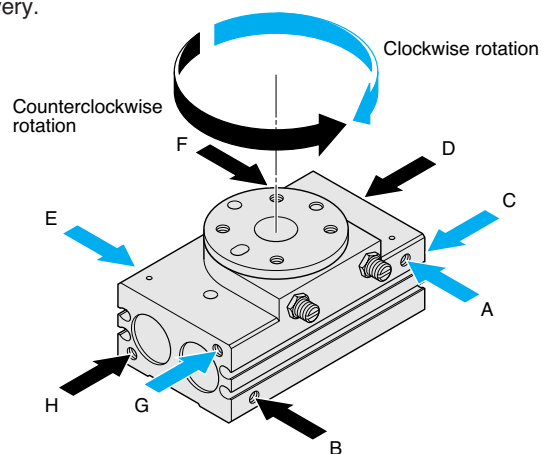
RAT5

The table swings in clockwise rotation when air is supplied to connection port A, and in counterclockwise rotation when air is supplied to connection port B. (The other surfaces do not have connection ports.)

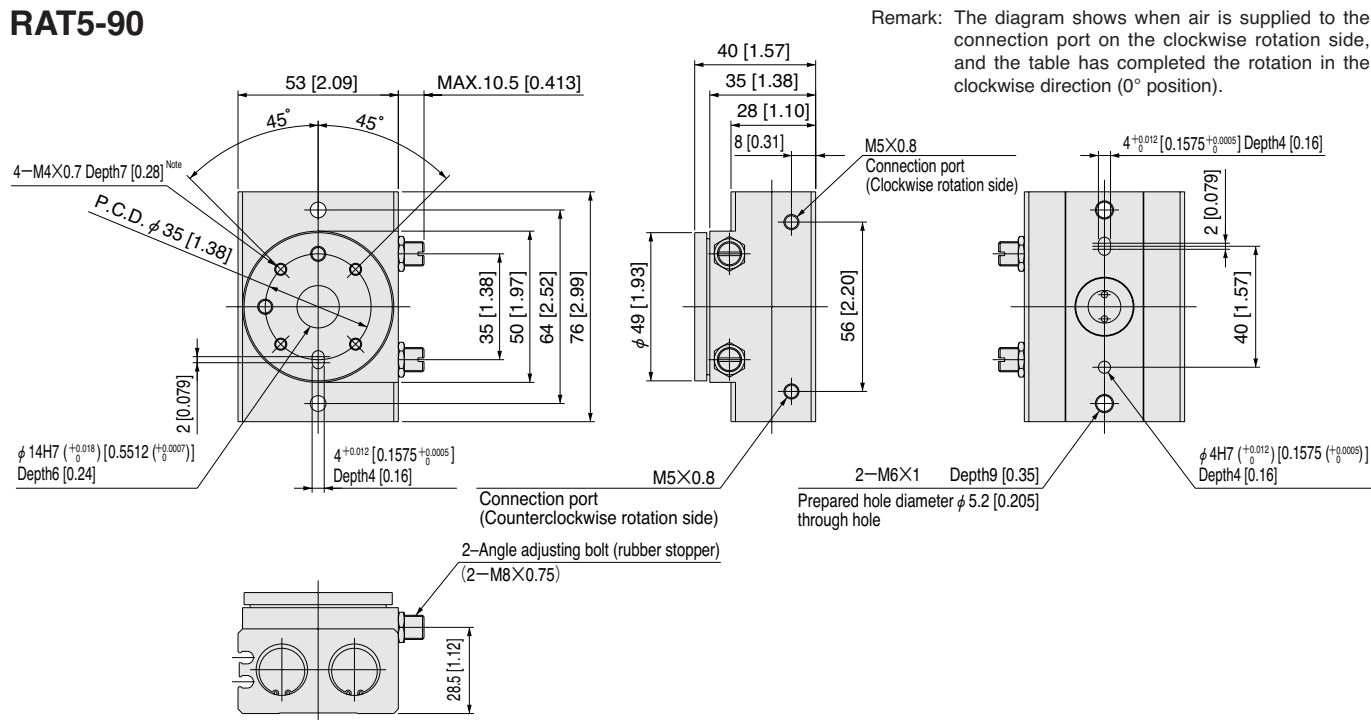


RAT10, 30

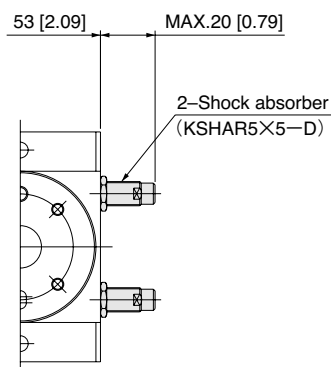
The table swings in clockwise rotation when air is supplied to connection ports A, C, E or G, and in counterclockwise rotation when air is supplied to connection ports B, D, F or H. Note that connection ports C, D, E, F, G and H are plugged at time of delivery.



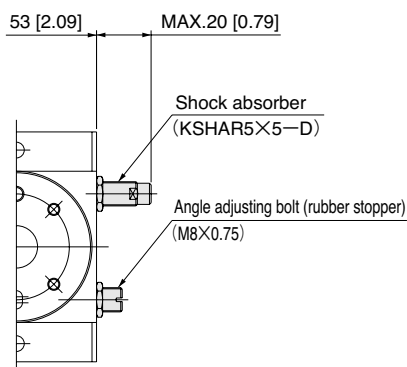
RAT5-90



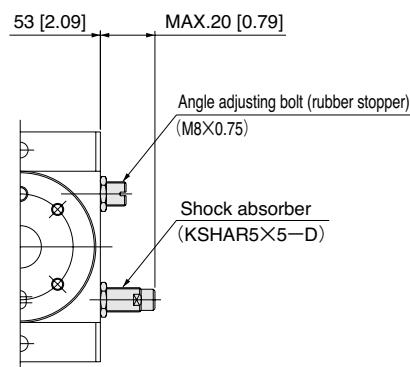
RAT5-90-SS2



RAT5-90-SSR

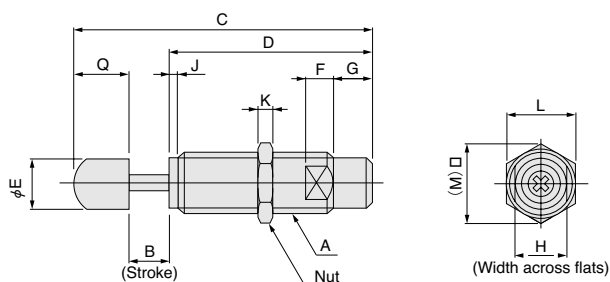


RAT5-90-SSL



Note: Do not screw the bolt deeper than the thread depth.
For mounting works on the table, see the Handling Instructions and Precautions, "Mounting," on p.7.

Shock Absorber Dimensions Unit: mm [in.]



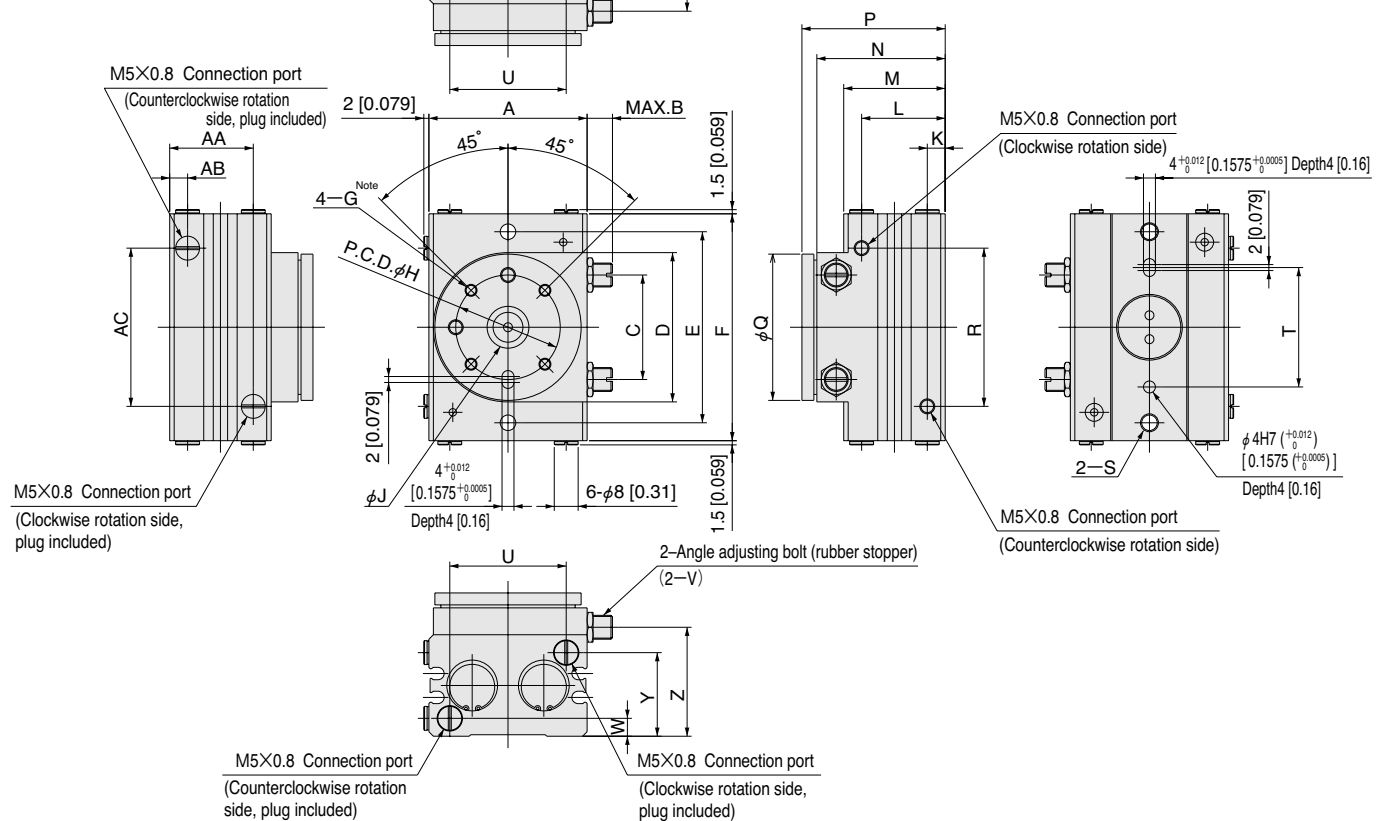
Model	A	B	C	D	E	F	G	H	J	K	L	M	Q
KSHAR5X5-D	M8X0.75	5 [0.20]	46 [1.81]	31 [1.22]	6 [0.24]	3 [0.12]	5 [0.20]	7 [0.28]	1.2 [0.047]	2 [0.079]	10 [0.39]	11.5 [0.453]	10 [0.39]
KSHAR5X5-E	M8X0.75	5 [0.20]	46 [1.81]	31 [1.22]	6 [0.24]	3 [0.12]	5 [0.20]	7 [0.28]	1.2 [0.047]	2 [0.079]	10 [0.39]	11.5 [0.453]	10 [0.39]
KSHAR6X8-F	M10X1	8 [0.31]	61 [2.40]	45 [1.77]	8 [0.31]	4 [0.16]	5 [0.20]	9 [0.35]	2 [0.079]	3 [0.12]	12 [0.47]	13.9 [0.547]	8 [0.31]

RAT10-90
RAT30-90

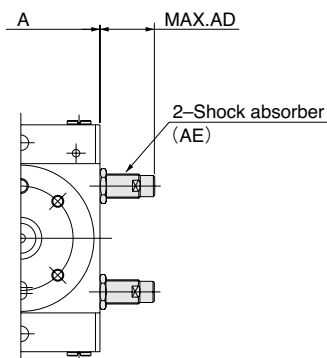
M5×0.8 Connection port
(Counterclockwise rotation
side, plug included)

M5X0.8 Connection port
(Clockwise rotation side,
plug included)

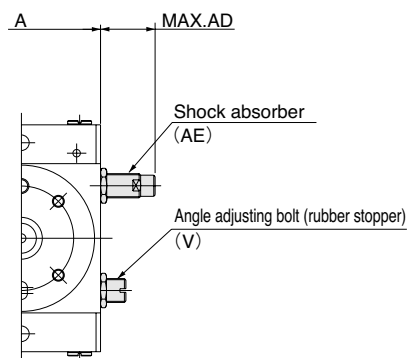
Remark: The diagram shows when air is supplied to the connection port on the clockwise rotation side, and the table has completed the rotation in the clockwise direction (0° position).



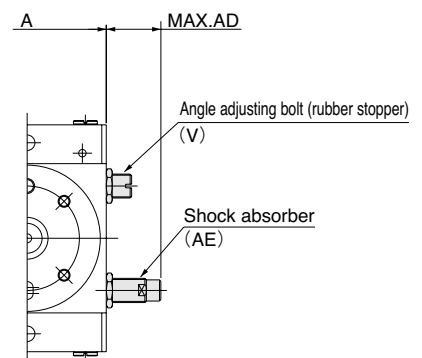
RAT10-90-SS2
RAT30-90-SS2



RAT10-90-SSR
RAT30-90-SSR



RAT10-90-SSL
RAT30-90-SSL

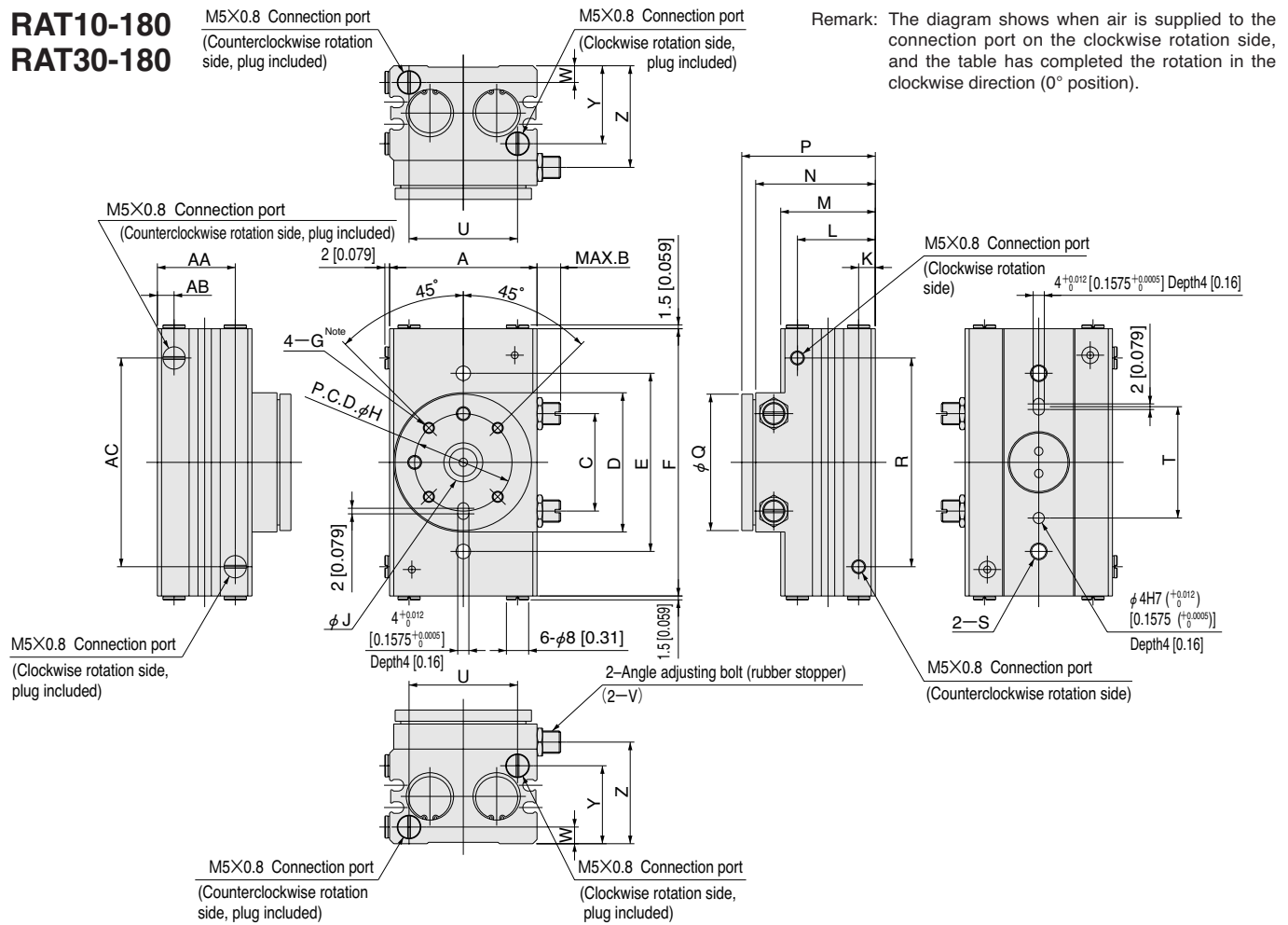


Note: Do not screw the bolt deeper than the thread depth.
For mounting works on the table, see the Handling Instructions and Precautions, "Mounting," on p.7.

Model \ Code	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
RAT10	53 [2.09]	10.5 [0.413]	35 [1.38]	50 [1.97]	64 [2.52]	76 [2.99]	M4×0.7 Depth7 [0.28]	35 [1.38] Depth6 [0.24]	14H7 ^(+0.018 0) [0.5512 ^(+0.0007 0)]	6 [0.24]	28 [1.10]	34 [1.34]	43 [1.69]	48 [1.89]	49 [1.93]	53 [2.09]
RAT30	63 [2.48]	11.5 [0.453]	44 [1.73]	60 [2.36]	72 [2.83]	102 [4.02]	M6×1 Depth8 [0.31]	44 [1.73] Depth12 [0.47]	18H7 ^(+0.018 0) [0.7087 ^(+0.0007 0)]	6 [0.24]	35 [1.38]	41 [1.61]	54 [2.13]	60 [2.36]	59 [2.32]	84 [3.31]

Model	Code	S	T	U	V	W	Y	Z	AA	AB	AC	AD	AE
RAT10	M6×1	Depth9 [0.35]	40	39	M8×0.75	6	28	36.5	28	6	53	20	KSHAR5×5-E
	Prepared hole diameter ϕ 5.2 [0.20] through hole		[1.57]	[1.54]		[0.24]	[1.10]	[1.44]	[1.10]	[0.24]	[2.09]	[0.787]	
RAT30	M8×1.25	Depth12 [0.47]	48	50	M10×1	6	35	46.5	35	6	84	27	KSHAR6×8-F
	Prepared hole diameter ϕ 6.6 [0.26] through hole		[1.89]	[1.97]		[0.24]	[1.38]	[1.83]	[1.38]	[0.24]	[3.31]	[1.06]	

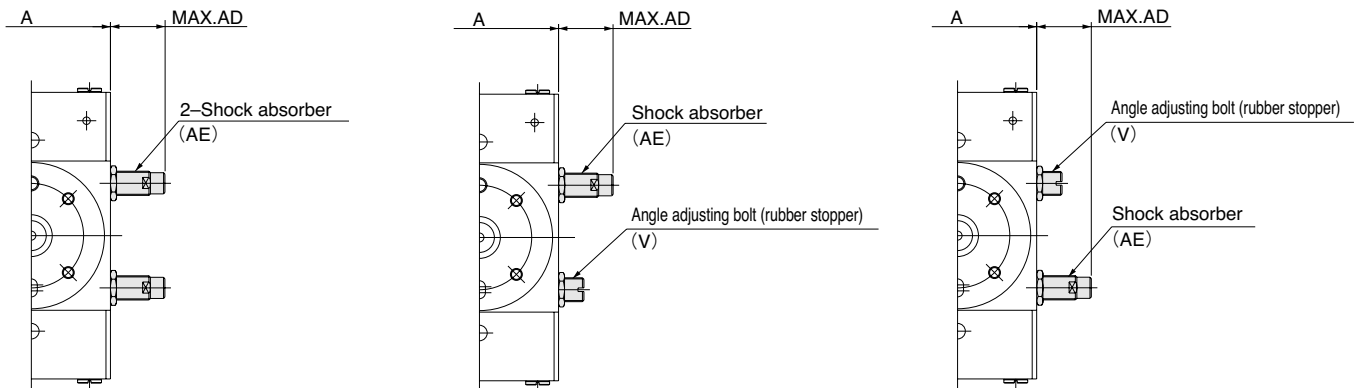
RAT10-180
RAT30-180



RAT10-180-SS2
RAT30-180-SS2

RAT10-180-SSR
RAT30-180-SSR

RAT10-180-SSL
RAT30-180-SSL



Note: Do not screw the bolt deeper than the thread depth.
For mounting works on the table, see the Handling Instructions and Precautions, "Mounting," on p.7.

Model	Code	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
RAT10	53	10.5	35	50	64	96	M4X0.7	Depth7	35	14H7(+0.018/-0.007)	6	28	34	43	48	49	75
	[2.09]	[0.413]	[1.38]	[1.97]	[2.52]	[3.78]		[0.28]	[1.38]	Depth6	[0.24]	[1.10]	[1.34]	[1.69]	[1.89]	[1.93]	[2.95]
RAT30	63	11.5	44	60	72	135	M6X1	Depth8	44	18H7(+0.018/-0.007)	6	35	41	54	60	59	117
	[2.48]	[0.453]	[1.73]	[2.36]	[2.83]	[5.32]		[0.31]	[1.73]	Depth12	[0.24]	[1.38]	[1.61]	[2.13]	[2.36]	[2.32]	[4.61]

Model	Code	S	T	U	V	W	Y	Z	AA	AB	AC	AD	AE
RAT10		M6X1	40	39	M8X0.75	6	28	36.5	28	6	75	20	KSHAR5X5-E
		Depth9	[1.57]	[1.54]		[0.24]	[1.10]	[1.44]	[1.10]	[0.24]	[2.95]	[0.787]	
RAT30		M8X1.25	48	50	M10X1	6	35	46.5	35	6	117	27	KSHAR6X8-F
		Depth12	[1.89]	[1.97]		[0.24]	[1.38]	[1.83]	[1.38]	[0.24]	[4.61]	[1.06]	

Sensor Switch

Solid State Type and Reed Switch Type

Specifications

● Solid State Type

Item \ Model	ZE135	ZE155	ZE235	ZE255
Wiring	2-lead wires		3-lead wires	
Lead wire direction	Horizontal		Vertical	
Power supply voltage	—	DC4.5~28V	—	DC4.5~28V
Load voltage	DC10~28V	DC4.5~28V	DC10~28V	DC4.5~28V
Load current	4~20mA (At 25°C[77°F]; 10mA at 60°C[140°F])	50mA MAX.	4~20mA (At 25°C[77°F]; 10mA at 60°C[140°F])	50mA MAX.
Consumption current	—	10mA MAX. (DC24V)	—	10mA MAX. (DC24V)
Internal voltage drop ^{Note 1}	4.5V MAX.	0.5V MAX (but at 20mA when voltage is 10V or less)	4.5V MAX.	0.5V MAX (but at 20mA when voltage is 10V or less)
Leak current	1mA MAX. (DC24V, 25°C)	50μA MAX.(DC24V)	1mA MAX. (DC24V, 25°C)	50μA MAX.(DC24V)
Response time	1ms MAX.			
Insulation resistance	100MΩ MIN. (with DC500V megger, between case and lead wire terminals)			
Dielectric strength	AC500V (50/60Hz) in one minute (between case and lead wire terminals)			
Shock resistance ^{Note 2}	294.2m/s ² [965ft/s ²] {30.0G} (non-repeating)			
Vibration resistance ^{Note 2}	Total amplitude 1.5mm [0.059in.] • 10~55Hz {88.3m/s ² [290ft/s ²] (9.0G)}			
Protective structure	IEC IP67, JIS C0920 (watertight type)			
Operation indicator	Red LED indicator lights up when ON			
Lead wires	PCCV 0.2SQ x 2 leads (brown and blue) x ℓ ^{Note3}	PCCV 0.15SQ x 3 leads (brown, blue and black) x ℓ ^{Note3}	PCCV 0.2SQ x 2 leads (brown and blue) x ℓ ^{Note3}	PCCV 0.15SQ x 3 leads (brown, blue and black) x ℓ ^{Note3}
Ambient temperature	0~60°C [32~140°F]			
Storage temperature range	-10~70°C [14~158°F]			
Mass	g[oz] 15 [0.53] (for lead wire length A: 1000mm [39in.]), 35 [1.23] (for lead wire length B: 3000mm [118in.])			

Notes: 1. Internal voltage drop will vary according to the load current.

2. According to Koganei test standards.

3. Lead wire length ℓ : A:1000mm [39in.], B: 3000mm [118in.]

● Reed Switch Type

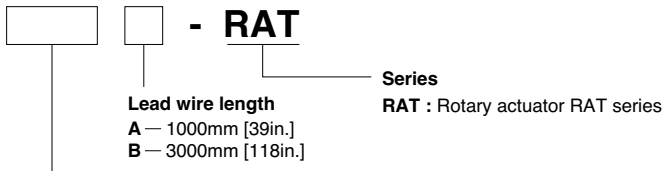
Item	Model	ZE101		ZE102		ZE201		ZE202	
Wiring		2-lead wires							
Lead wire direction		Horizontal				Vertical			
Load voltage		DC5~28V	AC85~115V(r.m.s)	DC10~28V	AC85~115V(r.m.s)	DC5~28V	AC85~115V(r.m.s)	DC10~28V	AC85~115V(r.m.s)
Load current		40mA MAX.	20mA MAX.	5~40mA	5~20mA	40mA MAX.	20mA MAX.	5~40mA	5~20mA
Internal voltage drop ^{Note 1}		0.1V MAX. (for load current of DC40mA)		3.0V MAX.		0.1V MAX. (for load current of DC40mA)		3.0V MAX.	
Leak current		0mA							
Response time		1ms MAX.							
Insulation resistance		100MΩ MIN. (with DC500V megger, between case and lead wire terminals)							
Dielectric strength		AC1500V (50/60Hz) in one minute (between case and lead wire terminals)							
Shock resistance ^{Note 2}		294.2m/s ² [965ft/s ²] {30.0G} (non-repeating)							
Vibration resistance ^{Note 2}		Total amplitude 1.5mm [0.059in.]•10~55Hz {88.3m/s ² [290ft/s ²] (9.0G)}, Resonant frequency 2570 ±250Hz							
Protective structure		IEC IP67, JIS C0920 (watertight type)							
Operation indicator		None	Red LED indicator lights up when ON			None	Red LED indicator lights up when ON		
Lead wires		PCCV 0.2SQ x 2 leads (brown and blue) x ℓ ^{Note3}							
Ambient temperature		0~60°C [32~140°F]							
Storage temperature range		-10~70°C [14~158°F]							
Contact protection		Required (See the contact protection on p.30.)							
Mass		g[oz] 15 [0.53] (for lead wire length A: 1000mm [39in.]), 35 [1.23] (for lead wire length B: 3000mm [118in.])							

Notes: 1. Internal voltage drop will vary according to the load current.

2. According to Koganei test standards.

3. Lead wire length ℓ : A:1000mm [39in.], B: 3000mm [118in.]

Order Code



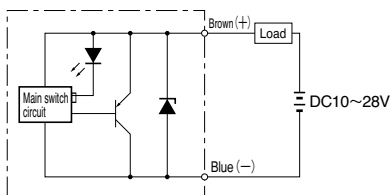
Type of sensor switch

ZE135 — Solid state type	With indicator lamp	DC10~28V	Horizontal lead wire	ZE155 — Solid state type	With indicator lamp	DC4.5~28V	Horizontal lead wire
ZE235 — Solid state type	With indicator lamp	DC10~28V	Vertical lead wire	ZE255 — Solid state type	With indicator lamp	DC4.5~28V	Vertical lead wire
ZE101 — Reed switch type	Without indicator lamp	DC5~28V AC85~115V	Horizontal lead wire	ZE102 — Reed switch type	With indicator lamp	DC10~28V AC85~115V	Horizontal lead wire
ZE201 — Reed switch type	Without indicator lamp	DC5~28V AC85~115V	Vertical lead wire	ZE202 — Reed switch type	With indicator lamp	DC10~28V AC85~115V	Vertical lead wire

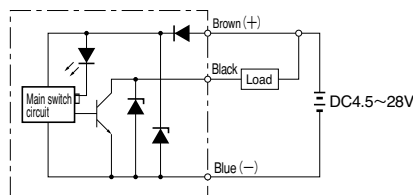
Internal Circuit Diagrams

● Solid state type

● 2-lead wire type

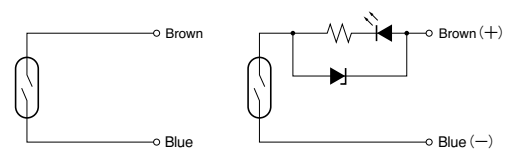


● 3-lead wire type



● Reed switch type

● Without indicator lamp ● With indicator lamp

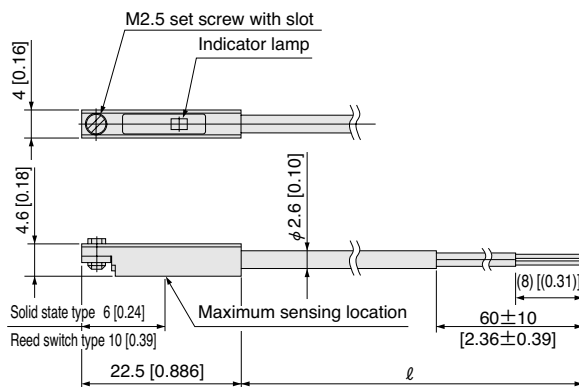


Sensor Switch Diagrams

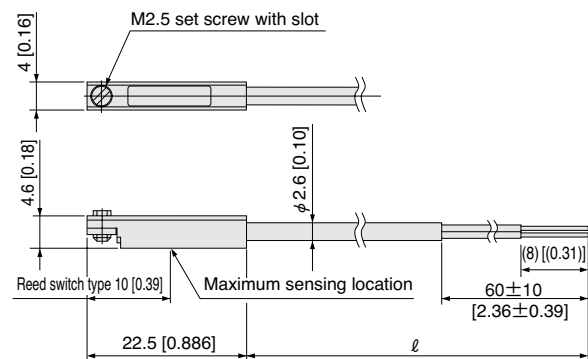
Unit: mm [in.]

● Horizontal lead wire

● With indicator lamp (ZE135, ZE155, ZE102)

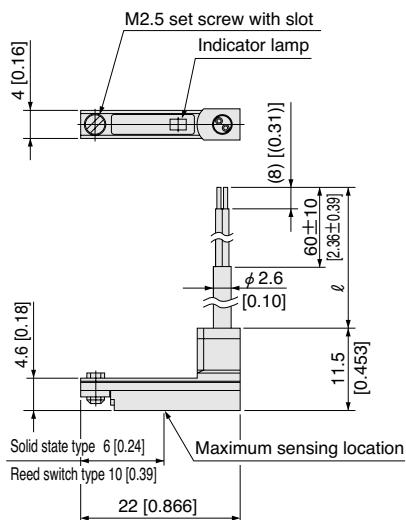


● Without indicator lamp (ZE101)

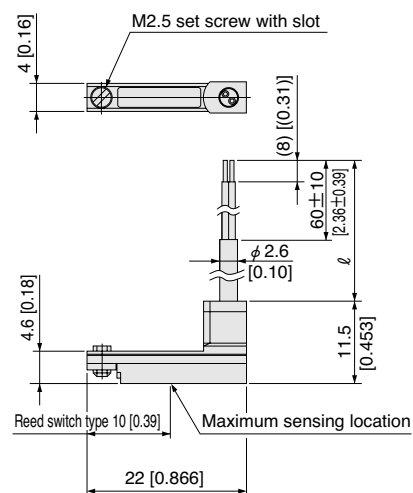


● Vertical lead wire

● With indicator lamp (ZE235, ZE255, ZE202)



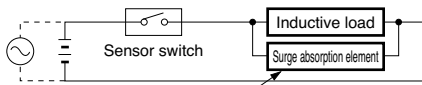
● Without indicator lamp (ZE201)



Contact Protection for Reed Sensor Switch Type

To ensure stable use of the reed type sensor switch, implement the following contact protection.

When connecting an inductive load (solenoid relay, etc.)



For DC: diode or CR, etc.

For AC: CR, etc.

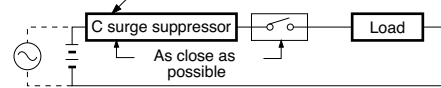
Diode: Forward direction capacity should exceed the circuit current, while the reverse direction should have reverse dielectric strength at least 10 times the circuit voltage.

C : 0.01~0.1 μ F
R : 1~4k Ω

When generating a capacitive surge

(When lead wire length exceeds 10m)

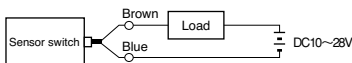
Choke coil : 1~5mH



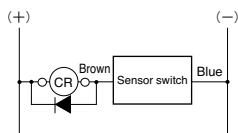
Wiring Instructions for Solid State Sensor Switch

2-lead wires type

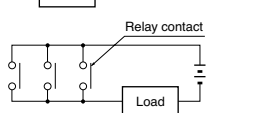
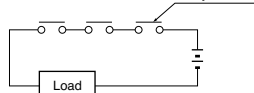
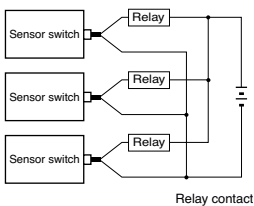
Basic connection



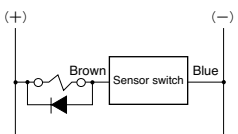
Connection to relay



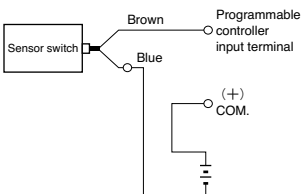
AND (serial) connection, OR (parallel) connection



Connection to solenoid valve

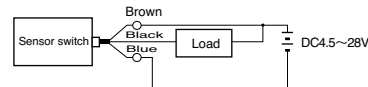


Connection to programmable controller

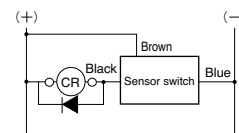


3-lead wires type

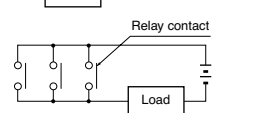
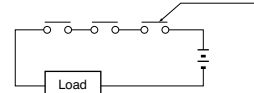
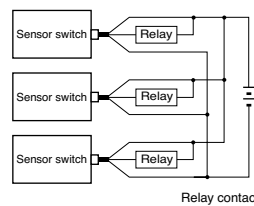
Basic connection



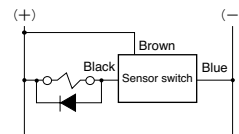
Connection to relay



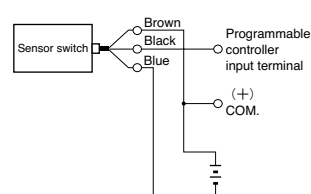
AND (serial) connection, OR (parallel) connection



Connection to solenoid valve

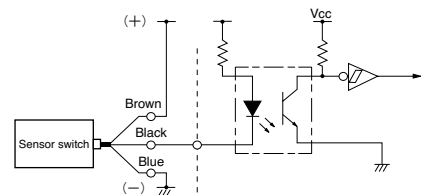


Connection to programmable controller

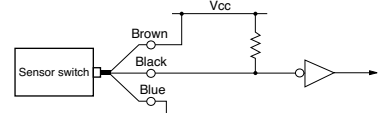


Connection to TTL

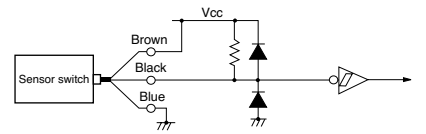
Separate connection



Direct connection



Connection to C-MOS

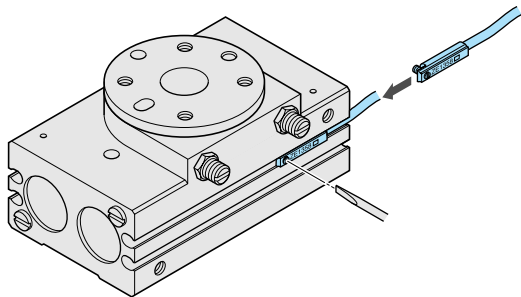


- cautions:**
1. Follow wire color code for proper connection. Miswiring could damage the switch due to the lack of surge protection measure.
 2. Do not connect the 2-wire solid state sensor switch to TTL or C-MOS.
 3. The use of surge protection diodes is recommended for the induction loads such as solenoids relays.
 4. Since the circuit voltage will drop in proportion to the used number of sensor switches, avoid use of AND (serial) connections.
 5. While pairs of sensor outputs (such as pairs of black wires) can be used with OR (parallel) connections, be aware that leakage voltage increases by several times the number of using sensor switches, and may cause load return abnormalities.

6. Since the sensor switches are magnetic-sensitive types, avoid using in locations subject to strong external magnetic fields, or bringing them too close to power lines or other large electric current. In addition, do not use magnetic materials for mounting bracket. It could result in abnormal operation.
7. Do not pull too strong on the lead wires, bend them too far, or apply excessive force to them.
8. Avoid use in environments subject to chemicals or gases, etc.
9. For use in oily or wet surroundings, consult with Koganei.

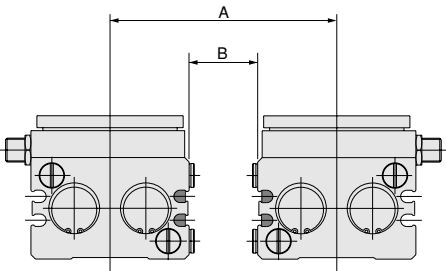
Sensor Switch Mounting Instructions

- Loose the set screw, slide the sensor switch along the switch mounting groove on the rotary actuator.
- Tighten the set screw with a tightening torque of $0.1\text{N}\cdot\text{m}\sim 0.2\text{N}\cdot\text{m}$ { $1\text{kgf}\cdot\text{cm}\sim 2\text{kgf}\cdot\text{cm}$ } [$0.07\sim 0.15\text{lb}\cdot\text{ft}$].



When Mounting the Sensor Switch in Close Proximity

If using the actuator in close proximity, use at the values shown in the table below, or higher.



●Solid State Type			mm [in.]
Model	A	B	
RAT5	70 [2.76]	17 [0.67]	
RAT10			
RAT30			

●Reed Switch Type			mm [in.]
Model	A	B	
RAT5	57 [2.24]	4 [0.16]	
RAT10			
RAT30			

Sensor Switch Operating Range, Response Differential, and Maximum Sensing Location

●Operating range: ℓ

The distance the piston travels in one direction, while the switch is in the ON position.

●Response Differential: C

The distance between the point where the piston turns the switch ON and the point where the switch turns OFF as the piston travels in the opposite direction.

●Solid State Type					mm [in.]
Item	Model	RAT5	RAT10	RAT30	
Operating range: ℓ		2.0~6.0 [0.08~0.24]			
Response differential: C		1.0 or less [0.04 or less]			
Maximum sensing location ^{Note}		6 [0.24]			

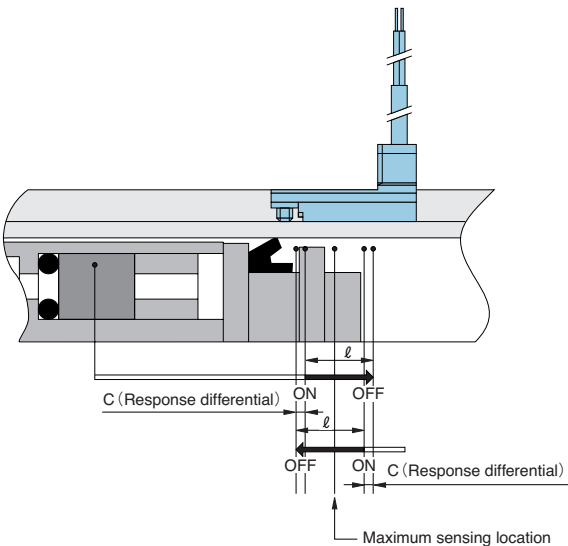
Remark: The above table shows reference values.

Note: Figure is measured from the side opposite to the lead wire.

●Reed Switch Type					mm [in.]
Item	Model	RAT5	RAT10	RAT30	
Operating range: ℓ		5.5~9.5 [0.22~0.37]			
Response differential: C		1.5 or less [0.059 or less]			
Maximum sensing location ^{Note}		10 [0.39]			

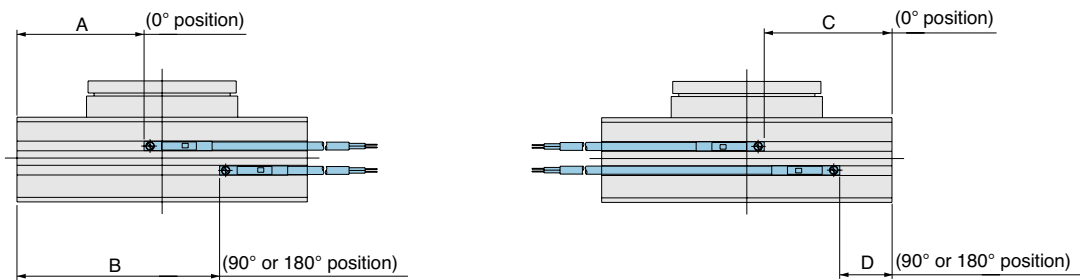
Remark: The above table shows reference values.

Note: Figure is measured from the side opposite to the lead wire.

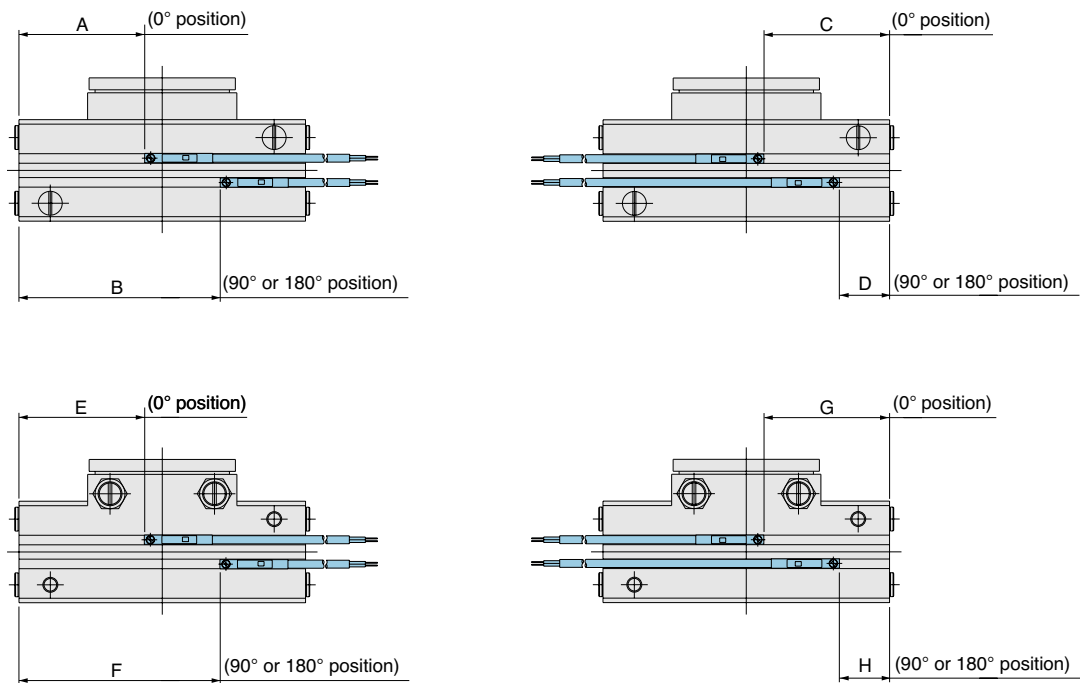


Mounting Position for Swing End Detection Sensor Switch

RAT5-90/180



RAT10-90/-180 RAT30-90/-180



Remark: For the table's 0°, 90° and 180° positions, see p.23.

● Solid State Type (ZE135 • ZE155 • ZE235 • ZE255)

mm [in.]

	90° position								180° position							
	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
RAT5	30.3 [1.19]	39.7 [1.56]	33.7 [1.33]	24.3 [0.957]	—	—	—	—	40.3 [1.59]	59.1 [2.33]	43.7 [1.72]	24.9 [0.980]	—	—	—	—
RAT10	30.3 [1.19]	39.7 [1.56]	33.7 [1.33]	24.3 [0.957]	30.3 [1.19]	39.7 [1.56]	33.7 [1.33]	24.3 [0.957]	40.3 [1.59]	59.1 [2.33]	43.7 [1.72]	24.9 [0.980]	40.3 [1.59]	59.1 [2.33]	43.7 [1.72]	24.9 [0.980]
RAT30	48.8 [1.92]	65.3 [2.57]	41.2 [1.62]	24.7 [0.972]	47.2 [1.86]	63.7 [2.51]	42.8 [1.69]	26.3 [1.04]	65.3 [2.57]	98.2 [3.87]	57.7 [2.27]	24.8 [0.976]	63.7 [2.51]	96.7 [3.81]	59.3 [2.33]	26.3 [1.04]

● Reed Switch Type (ZE101 • ZE102 • ZE201 • ZE202)

mm [in.]

	90° position								180° position							
	A	B	C	D	E	F	G	H	A	B	C	D	E	F	G	H
RAT5	26.3 [1.04]	35.7 [1.41]	29.7 [1.17]	20.3 [0.799]	—	—	—	—	36.3 [1.43]	55.1 [2.17]	39.7 [1.56]	20.9 [0.823]	—	—	—	—
RAT10	26.3 [1.04]	35.7 [1.41]	29.7 [1.17]	20.3 [0.799]	26.3 [1.04]	35.7 [1.41]	29.7 [1.17]	20.3 [0.799]	36.3 [1.43]	55.1 [2.17]	39.7 [1.56]	20.9 [0.823]	36.3 [1.43]	55.1 [2.17]	39.7 [1.56]	20.9 [0.823]
RAT30	44.8 [1.76]	61.3 [2.41]	37.2 [1.46]	20.7 [0.815]	43.2 [1.70]	59.7 [2.35]	38.8 [1.53]	22.3 [0.878]	61.3 [2.41]	94.2 [3.71]	53.7 [2.11]	20.8 [0.819]	59.7 [2.35]	92.7 [3.65]	55.3 [2.18]	22.3 [0.878]

Limited Warranty

KOGANEI CORP. warrants its products to be free from defects in material and workmanship subject to the following provisions.

Warranty Period The warranty period is 180 days from the date of delivery.

Koganei Responsibility If a defect in material or workmanship is found during the warranty period, KOGANEI will replace free of charge any part proved defective under normal use and will provide the service necessary to service such part.

Limitations

- This warranty is in lieu of all other warranties, expressed or implied, and is limited to the original cost of the product and shall not include any transportation, the cost of installation or any liability for direct, indirect or consequential damages or delay resulting from defects.

- KOGANEI CORP. shall in no way be liable or responsible for injuries or damages to persons or property arising out of the use or operation of the manufacturer's product.

- This warranty shall be void if the engineered safety devices are removed, made inoperative or not periodically checked for proper functioning.

- Any operation beyond the rated capacity, or the improper use, application, or installation of the product, or substitution upon it of parts not furnished or approved by KOGANEI CORP., shall void this warranty.

- This warranty covers only such items supplied by KOGANEI CORP. The products of other manufacturers are covered only by such warranties as made by these original manufacturers, even though such items may have been included as components.

These specifications are subject to change without notice.

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